Assessment of Water Quality in Kootenai River and Moyie River Subbasins (TMDL)

Final Public Comment Draft

Kootenai Tribe of Idaho
Department of Environmental Quality
United States Environmental Protection Agency

May 2006

Cover Photo: Cover photograph of Kootenai River meandering through adjacent valley agriculture and Selkirk Mountains in the distance. Photo taken by Nadine Nystrom and provided by Patty Perry.

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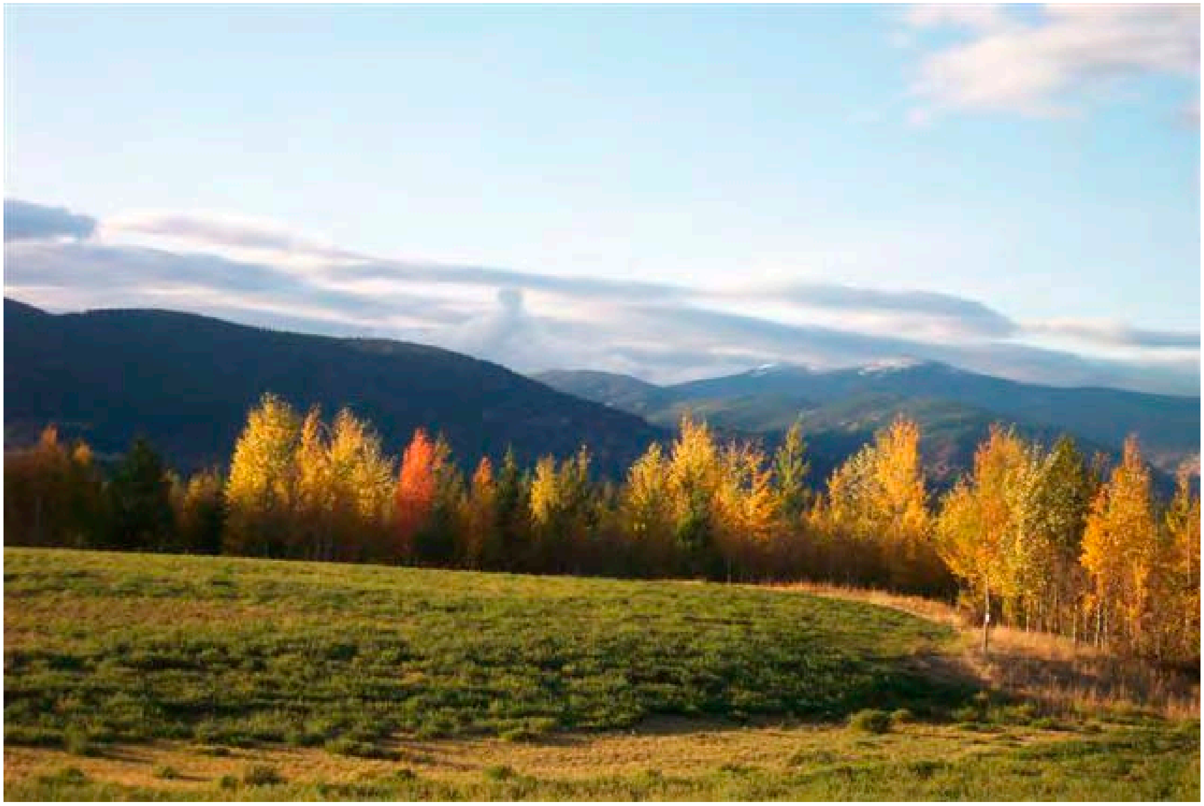

Burton Peak. Photo by Nadine Nystrom.

May 2006

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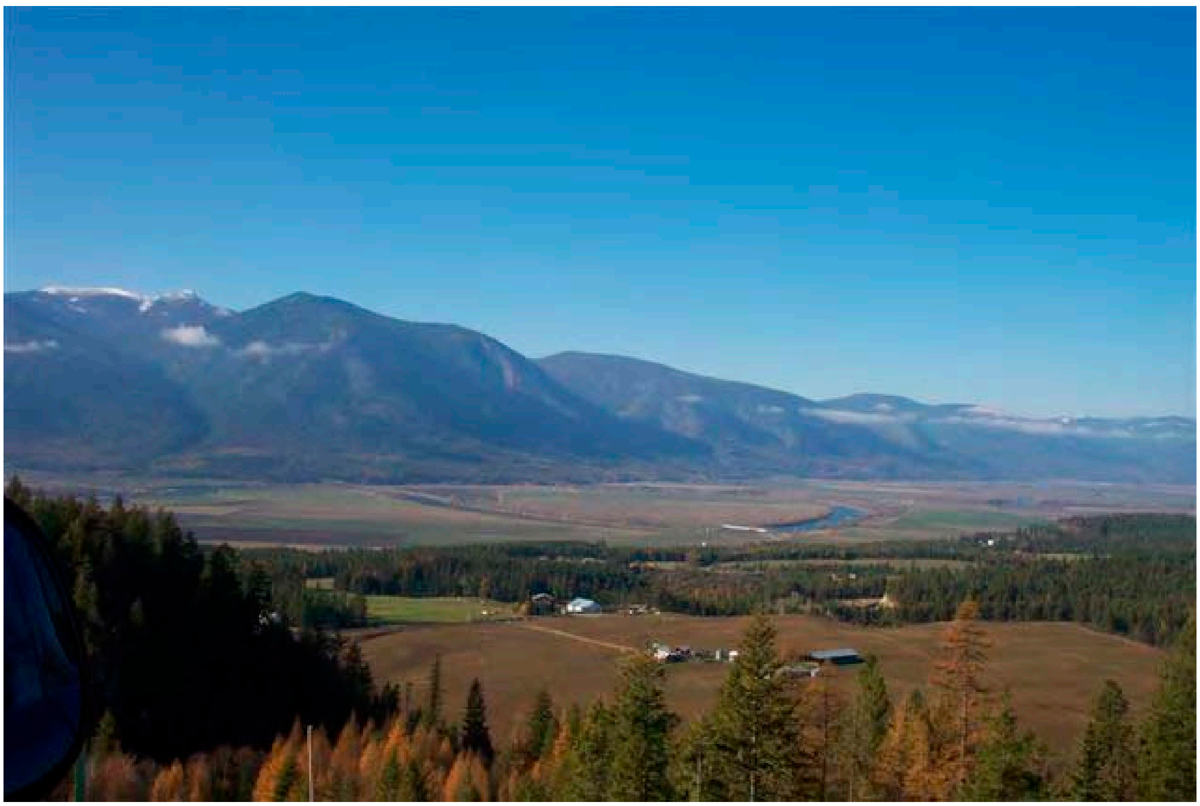

Kootenai River Valley. Photo by Nadine Nystrom.

Acknowledgments

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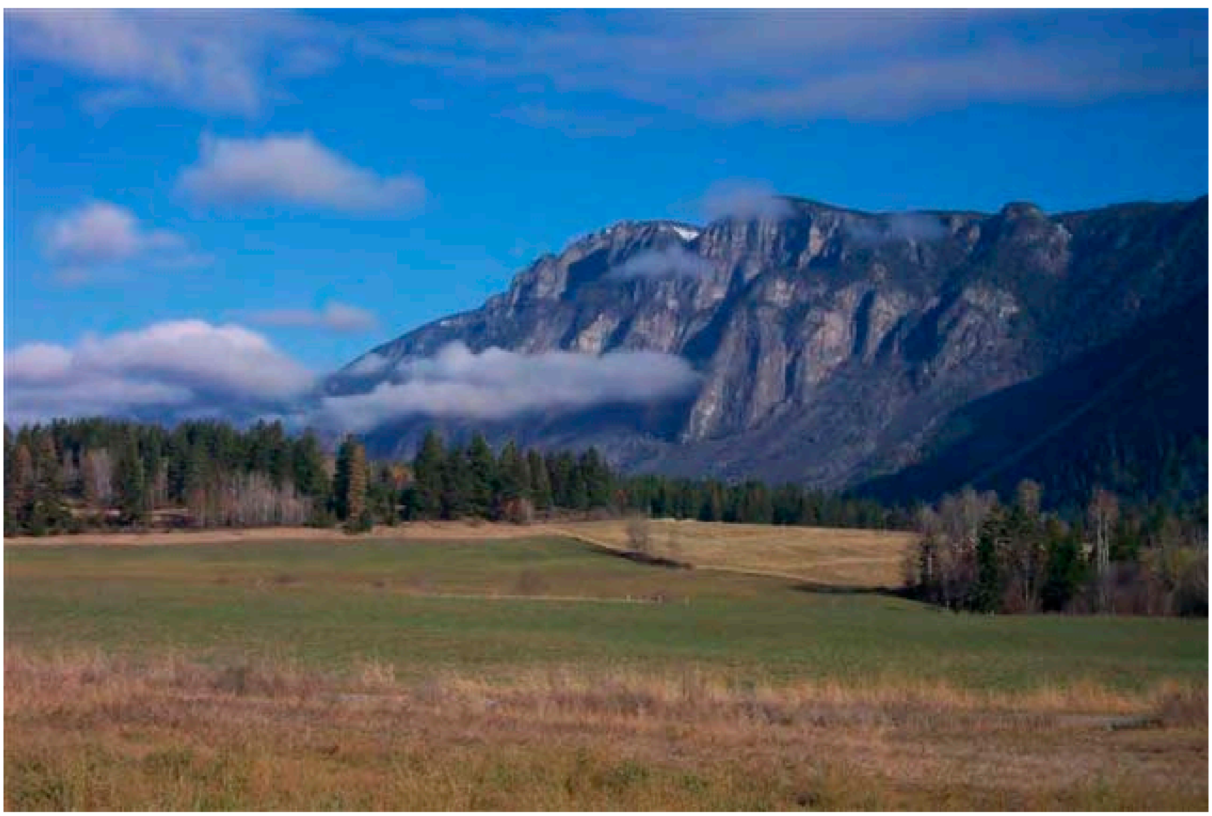

From Junction Hill looking north toward Port Hill. Photo by Nadine Nystrom.

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Kootenai River from West Side Road. Photo by Nadine Nystrom.

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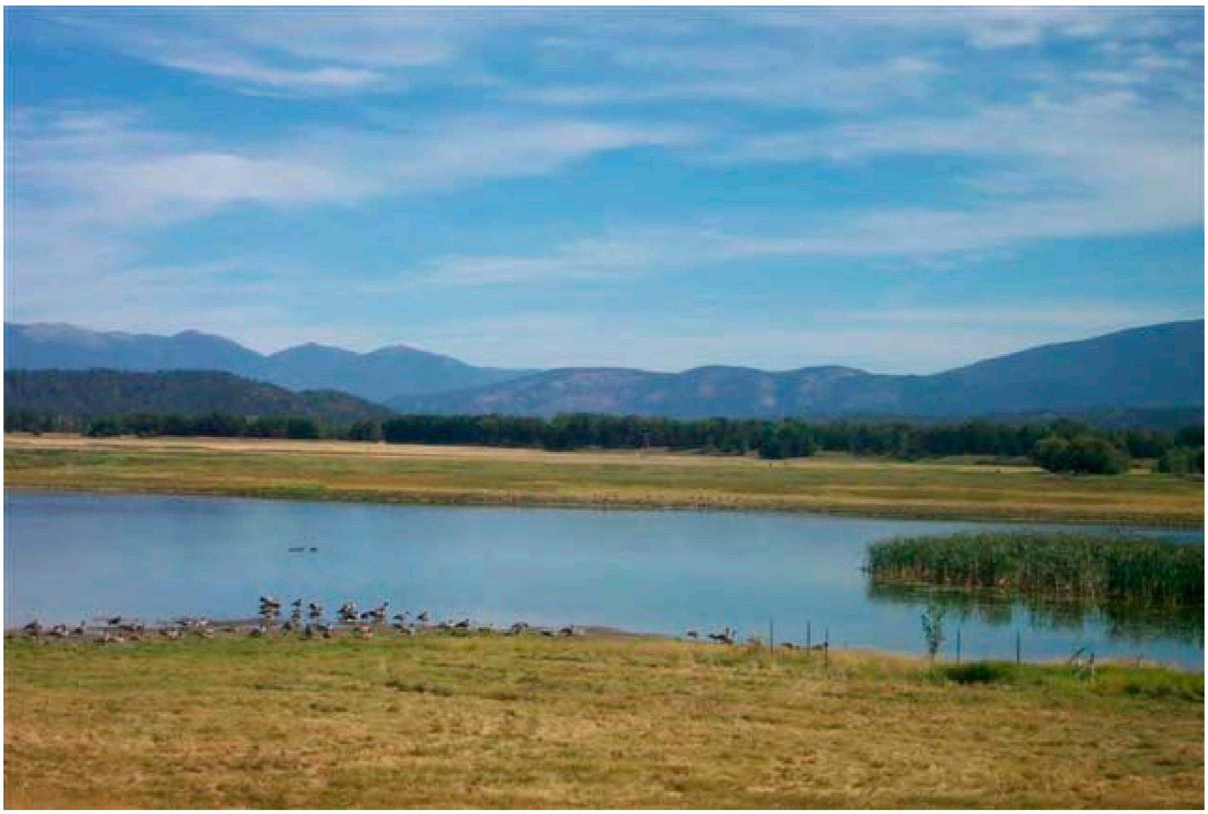

Kootenai National Wildlife Refuge. Photo by Nadine Nystrom.

Abbreviations, Acronyms, and Symbols

§303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section

µ micro, one-one thousandth

§ Section (usually a section of federal or state rules or statutes)

ADB assessment database

AU assessment unit

AWS agricultural water supply

BAG Basin Advisory Group

BLM United States Bureau of Land Management

BMP best management practice

BOD biochemical oxygen demand

BOR United States Bureau of Reclamation

Btu British thermal unit

BURP Beneficial Use Reconnaissance Program

C Celsius

CFR Code of Federal Regulations (refers to citations in the federal administrative rules)

cfs cubic feet per second

cm centimeters

CWA Clean Water Act

CWAL cold water aquatic life

CWE cumulative watershed effects

DEQ Department of Environmental Quality

DO dissolved oxygen

DOI U.S. Department of the Interior

DWS domestic water supply

EMAP Environmental Monitoring and Assessment Program

EPA United States Environmental Protection Agency

ESA Endangered Species Act

F Fahrenheit

FPA Idaho Forest Practices Act

FWS U.S. Fish and Wildlife Service

GIS Geographical Information Systems

HUC Hydrologic Unit Code

I.C. Idaho Code

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

IDWR Idaho Department of Water Resources

INFISH the federal Inland Native Fish Strategy

IRIS Integrated Risk Information System

km kilometer

km^2 square kilometer

LA load allocation

LC load capacity

m meter

m^3 cubic meter

mi mile

mi^2 square miles

MBI Macroinvertebrate Biotic Index

MGD million gallons per day

mg/L milligrams per liter

mm millimeter

MOS margin of safety

MRCL multiresolution land cover

MWMT maximum weekly maximum temperature

n.a. not applicable

NA not assessed

NB natural background

nd no data (data not available)

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephelometric turbidity unit

ORV off-road vehicle

ORW Outstanding Resource Water

PACFISH the federal Pacific Anadromous Fish Strategy

PCR primary contact recreation

PFC proper functioning condition

ppm part(s) per million

PNV potential natural vegetation

QA quality assurance

QC quality control

RBP rapid bioassessment protocol

RDI DEQ's River Diatom Index

RFI DEQ's River Fish Index

RHCA riparian habitat conservation area

RMI DEQ's River Macroinvertebrate Index

RPI DEQ's River Physiochemical Index

SBA subbasin assessment

SCR secondary contact recreation

SFI DEQ's Stream Fish Index

SHI DEQ's Stream Habitat Index

SMI DEQ's Stream Macroinvertebrate Index

SRP soluble reactive phosphorus

SS salmonid spawning

SSOC stream segment of concern

STATSGO State Soil Geographic Database

TDG total dissolved gas

TDS total dissolved solids

T&E threatened and/or endangered species

TIN total inorganic nitrogen

TKN total Kjeldahl nitrogen

TMDL total maximum daily load

TP total phosphorus

TS total solids

TSS total suspended solids

t/y tons per year

t/a/y tons per acre per year

U.S. United States

U.S.C. United States Code

USDA United States Department of Agriculture

USDI United States Department of the Interior

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WBID water body identification number

WET whole effluence toxicity

WLA wasteload allocation

WQLS water quality limited segment

WQMP water quality management plan

WQRP water quality restoration plan

WQS water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife, while providing for recreation in and on the nation's waters whenever possible. Subsection 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

The Lower Kootenai and Moyie Rivers Subbasin Assessment (SBA) and TMDL have been developed for streams listed on the 1998 §303(d) list. The 2002 §303(d) list was approved by the Environmental Protection Agency (EPA) in December 2005 after this SBA and TMDL was substantially complete. When practical, information from the 2002 list is included in this document.

This SBA and TMDL analysis has been developed to comply with Idaho's TMDL schedule. The assessment describes the physical, biological, and cultural setting, water quality status, pollutant sources, and recent pollution control actions in the Lower Kootenai and Moyie River Subbasins, located in northeastern Idaho.

The first part of this document, the SBA, is an important first step in developing the TMDL. The starting point for this assessment was Idaho's 1998 §303(d) list of water quality limited water bodies. Seven segments of the Lower Kootenai and Moyie River Subbasins were included on this list. The SBA examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The second part of this document, the TMDL analysis, quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Subbasins:	Upper Kootenai (17010101, does not include any listed stream segments), Lower Kootenai (17010104), and Moyie (17010105)
Key Resource:	Aquatic Life and Habitat
Uses Affected:	Cold Water Aquatic Life, Salmonid Spawning
Pollutants:	Sediment Metals pH Temperature
Pollutant sources considered:	
Agriculture, Forest Practices, Roads, Railroads, Pipeline, Urbanizati**on, and Natural background**	

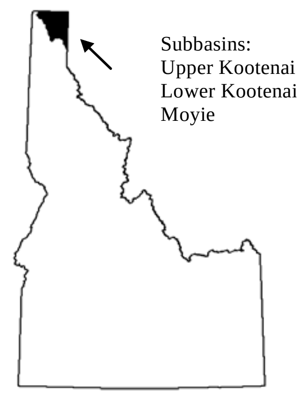

Figure 1. Subbasin at a Glance.

The Upper Kootenai River Subbasin (17010101) does not have any §303(d) listed stream segments in its Idaho portion, and most of the subbasin is in Montana, therefore, the Upper Kootenai River Subbasin will not be discussed often in this TMDL. The Lower Kootenai River Subbasin (17010104) is located at the very top of the panhandle of Idaho, bordering both Canada and Montana, with small portions in each. The Moyie River Subbasin (17010105) is in the very northeast corner of Idaho, also bordering both Canada and Montana, with small portions in each, and surrounded on the west and south by the Lower Kootenai River Subbasin. (Figure 18 on page 38 shows all three subbasins.)

- The **Kootenai River** flows west-northwest into Idaho from Libby, Montana, turns north after Bonners Ferry, and flows into Canada.
- The **Moyie River,** which first flows southward through the Moyie River Subbasin, joins the Kootenai River near Moyie Springs, after the Kootenai River has crossed from Montana into Idaho.

Deep Creek was originally listed on the 1998 Idaho §303(d) list of impaired waters for sediment pollution. Later, when EPA made additions to the 1998 Idaho §303(d) list for temperature pollution, Deep and Boundary Creeks were added (see Figure 2).

Deep Creek flows north through the Purcell Trench from the McArthur Lake area and joins the Kootenai River adjacent to the Kootenai National Wildlife Refuge. Deep Creek has its headwaters in the forest above McArthur Lake, and flows through a mix of deciduous/conifer vegetation types on predominantly private land along Highway 95. Deep Creek is likely to have experienced a variety of impacts over the years. From a stream temperature standpoint, it is important to note that Deep Creek receives much of its flow from McArthur Lake, a shallow, warm water lake.

Boundary Creek enters Idaho from Canada and flows east to the Kootenai River, re-entering Canada approximately three miles before it enters the Kootenai River. Boundary Creek appears to flow through mostly intact forest on national forest land with only some minor clearing of timber at its lower end. Much of the Boundary Creek watershed is in Canada, thus land use activities and their effects on stream temperature outside of the U.S. are not under the purview of the state of Idaho.

In 2002, DEQ conducted additional assessments of streams in Idaho. Deep and Boundary Creeks were assessed at that time and found to be not supporting aquatic life uses (cold water and salmonid spawning). Deep Creek[1] had the sediment pollution listing from 1998 carried over into the 2002 assessment, and was also found to be thermally modified. Boundary Creek[2] was found to be impacted by metals pollution and thermal modification. The streams macroinvertebrate scores deviated from reference conditions and violations of temperature criteria recorded.

Air temperatures are in the Kootenai and Moyie Subbasins are related to elevation. Stream temperatures in turn are affected by the air temperature. The Kootenai and Moyie Subbasins are the lowest elevation, forested subbasins in the state. Indicators of ambient air temperature for Deep and Boundary Creeks are summarized in Figure 3 and Figure 4.

[1] AU# ID17010104PN015_04, ID17010104PN018_04, ID17010104PN019_04, and ID17010104PN022_03
[2] AU# ID17010104PN002_02 and ID17010104PN002_03

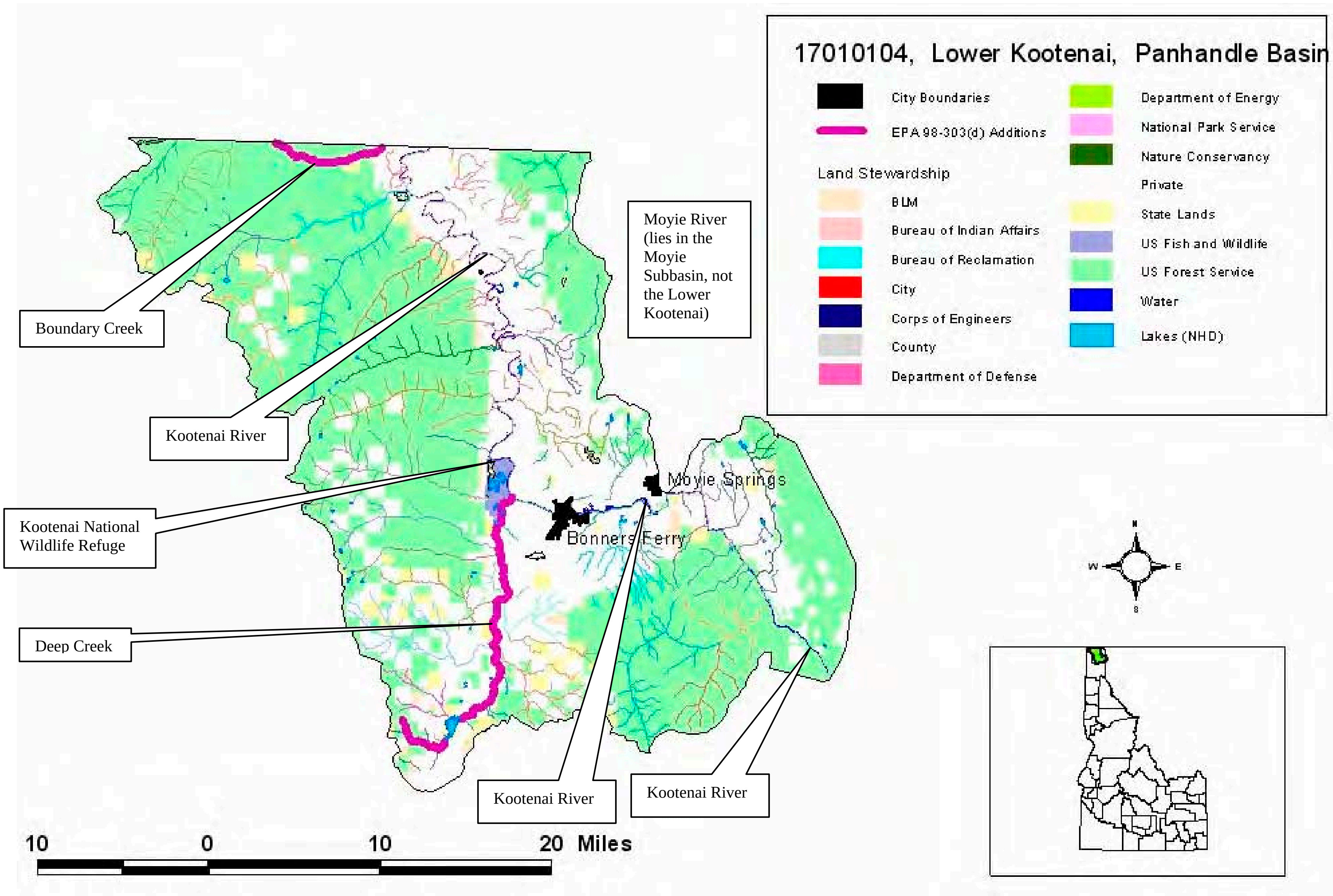

Figure 2. Lower Kootenai River Subbasin details.

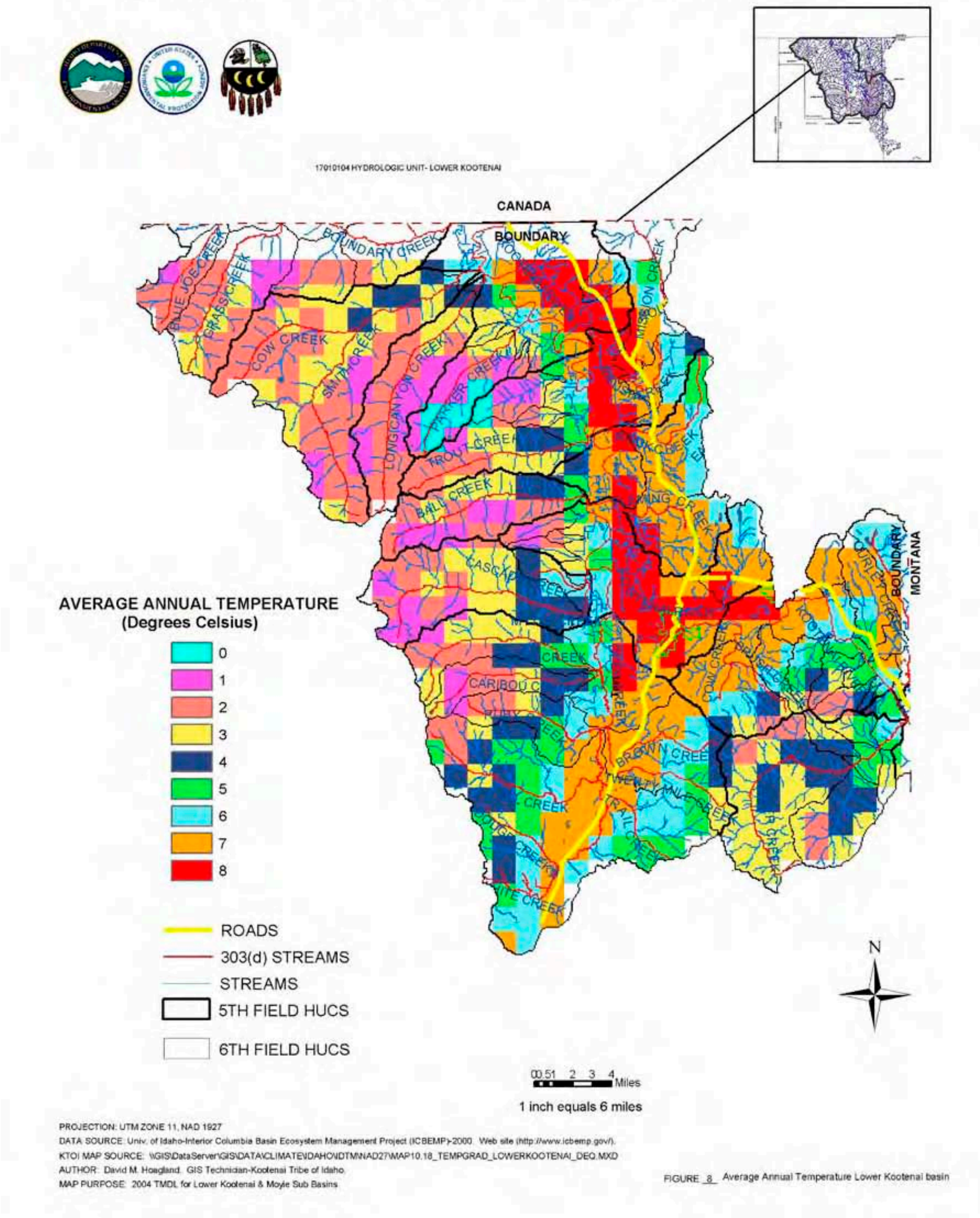

Figure 3. Average Annual Temperature for Lower Kootenai River Subbasin in 1989.

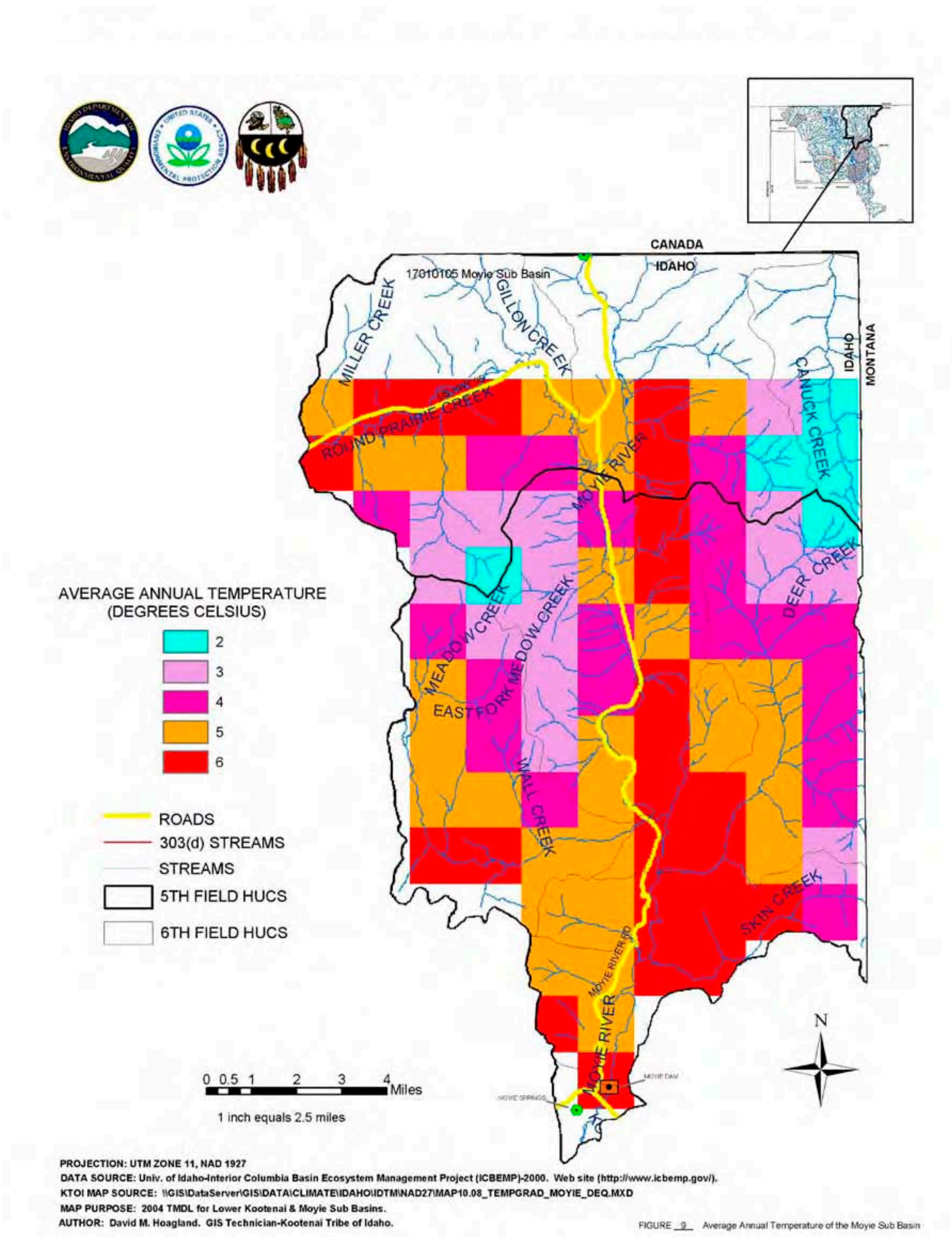

Figure 4. Average Annual Temperature for Moyie River Subbasin in 1989.

Key Findings

The Lower Kootenai and Moyie watersheds remained in a relatively natural condition until the early twentieth century when miners, loggers, and ranchers began to settle in the area. The watershed has a history of timber harvest and some grazing, which, in recent years, has been restricted to the floodplain of the lower portion of the Kootenai River. In 1998, seven stream segments in the two subbasins were §303(d) listed for sediment, temperature, metals, and pH. Table E-1 shows the stream segments listed in 1998, along with the pollutants for which they were listed at that time. During the development of the Kootenai and Moyie SBA and TMDL the 1998 §303(d) list was the most recently EPA approved list.

In December 2005 EPA approved section 5 of the 2002 Integrated Report. Similar to the 1998 §303(d) list, section 5 of the 2002 Integrated Report is a requirement of the Clean Water Act, listing surface waters which are failing to meet surface water quality standards. Thirty four temperature, two unknown and one sediment additions were made to section 5 of the 2002 Integrated Report within the Lower Kootenai HUC in Idaho. Eleven temperature and one unknown additions were made to the Moyie HUC in Idaho. The Kootenai and Moyie rivers SBA and TMDL were developed using the 1998 §303(d) list.

Table E-1. 1998 §303(d) listed streams and pollutants considered in Subbasin Assessment.

Stream	Waterbody ID	Description	Pollutant(s)
Blue Joe Creek	ID17010104PN004_02	First and second order portion of Blue Joe Creek from headwaters to Idaho/Canadian border	Metals [1], pH[1], Sediment[1]
Boulder Creek	ID17010104PN032_03	Third order portion of Boulder Creek from East Fork Boulder Creek to mouth	Sediment[1]
	ID17010104PN033_02	First and second order portion of Boulder Creek from headwaters to East Fork Boulder Creek	
	ID17010104PN033_03	Third order portion of Boulder Creek from headwaters to East Fork Boulder Creek	
Boundary Creek	ID17010104PN002_02	First and second order portions of Boundary Creek from Idaho/Canadian border back to Canadian border, including main stem Boundary Creek to Fan Creek	Temperature[2]
	ID17010104PN002_03	Third Order portion of Boundary Creek main stem from Fan Creek to Canadian Border near Kootenai River	
Caribou Creek	ID17010104PN017_02	First and second order portions of Caribou Creek From Roman Nose Lakes to confluence with Deep Creek	Sediment[1]
Cow Creek	ID17010104PN006_02	First and second order portions of Cow Creek and Beaver Creek from headwaters to Cow Creek's confluence with Beaver Creek	Sediment[1]
	ID17010104PN006_03	Third order portion of Cow Creek downstream from confluence with Beaver Creek to Smith Creek	
Deep Creek	ID17010104PN025_02	First and second order portions of Deep Creek upstream of McArthur Lake	Temperature[2]
	ID17010104PN022_03	Third order portion of Deep Creek from McArthur Lake to Trail Creek	Sediment[1], Temperature[2]
	ID17010104PN019_04	Fourth order portion of Deep Creek from Trail Creek to Twentymile Creek	

Stream	Waterbody ID	Description	Pollutant(s)
	ID17010104PN018_04	Fourth order portion of Deep Creek from Twentymile Creek to Snow Creek	
	ID17010104PN015_04	Fourth order portion of Deep Creek from Snow Creek to Kootenai River	
Moyie River	ID17010105PN001_05	Fifth order portion of Moyie River from Moyie River Dam to Kootenai River	Sediment[1]

1 – 1998 §303(d) List (DEQ 1998)
2 – EPA's Additions to the 1998 Idaho §303(d) List (EPA 1998)

Six of the seven streams were listed for sediment, two for temperature, and one for metals and pH. The sediment in the subbasin is primarily from road crossings and encroachment. Temperature is most affected by stream shading. Metals and pH exceedances stem from historic mining activity near the headwaters of Blue Joe Creek.

Impairment of cold water use was commonly assessed using composite scores of fish, macroinvertebrate, and habitat indices. These scores generally indicate full support of beneficial uses in most streams assessed in the subbasin, but they also indicate use impairment in some tributaries to the Kootenai River. Monitoring stations on Blue Joe Creek, Boulder Creek, Caribou Creek, Cow Creek, and Deep Creek had index scores below the threshold of full support during the 1998 assessment. Deep Creek and Boundary Creek had temperatures exceeding Idaho's Water Quality Criteria. The Kootenai River itself was not §303(d) listed nor was it found to be impaired in the 1998 assessment.

Water temperatures are an issue in the Lower Kootenai and Moyie Subbasins. An SBA and TMDL for water temperatures was developed in 2005, however, before the temperature SBA/TMDL was completed, the Kootenai and Moyie River Basin Watershed Advisory Group decided they could support the approach and suggested to incorporate it into this TMDL which initially addressed only sediment, plus metals and pH for Blue Joe Creek. (The working title of the temperature SBA and TMDL was *Boundary Creek and Deep Creek Temperature Total Maximum Daily Loads: Addendum to the Lower Kootenai River Subbasin Assessment and TMDL.)* Additionally, an assessment of temperature data in 2002 indicates that <u>all</u> monitored streams in the Lower Kootenai and Moyie Subbasins exceed Idaho temperature criteria. In a situation where <u>all</u> streams, including un-disrupted streams, have numeric criteria exceedances, a special look at natural conditions must be taken into account. The Lower Kootenai and Moyie watersheds are located in the northern most portion of Idaho at relatively low elevations. Throughout the state it has been demonstrated that water temperatures are most strongly affected by air temperatures which directly relate to elevation. The Lower Kootenai and Moyie Subbasins are the lowest-elevation forested subbasins in the state. Future SBAs and TMDLs will need to address watershed-wide natural conditions, temperature targets, and acceptable temperature loading.

Metals and pH are identified as pollutants for Blue Joe Creek. At the time of the 1998 assessment, Blue Joe Creek was void of aquatic insect life and was impaired. The source of metals and associated pH issues is the now abandoned Continental Mine. Through environmental cleanup activities, both the Idaho Department of Environmental Quality Remediation Section and the USDA Forest Service have been actively reducing metals and pH loading over the last three years. All reasonable TMDL implementation activities for metals and pH loading are complete, and Blue Joe Creek is in a state of recovery. Aquatic insects have started to re-occupy Blue Joe Creek, and it is reasonable to assume that through the combination of remediation activities that have occurred and future sediment reduction efforts that Blue Joe Creek will be fully supporting all beneficial uses within the decade.

The 1998 §303(d) list includes the Moyie River, from the Moyie River Dam to its confluence with the Kootenai River. Excess sediment is the listed pollutant, and based on the 1998 determination, a TMDL would be required. DEQ does not have Beneficial Use Reconnaissance (BURP) monitoring data on this section of Moyie River, and believes the sediment listing decision was based on anecdotal understandings and information. DEQ has evidence that the listing resulted from a single fine sediment deposition event and that the stream has recovered since that event and therefore recommends delisting.

Three of the listed streams; Blue Joe Creek, Boulder Creek and Caribou Creek have been removed as candidates for sediment TMDL development, for the following reasons:

- Draft TMDLs demonstrated that current sediment generating conditions are better than those showing full support of the beneficial uses.
- The listings were based on 1995 BURP data that are contrary to data collected more recently.
- Stressor Identification Analysis (EPA 2000) performed by DEQ supports removal of these three streams as TMDL candidates.

After further analysis of available data, changes needed in the 1998 §303(d) list were apparent. Table E-2 shows delisting recommendations and the rationale for each.

Table E-2. Summary of assessment outcomes, including delisting recommendations.

Stream	Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Blue Joe Creek	ID17010104PN004_02	Metals	No	Category 4b candidate[1]	Remediation in progress
Blue Joe Creek	ID17010104PN004_02	pH	No	Category 4b candidate[1]	Remediation in progress
Blue Joe Creek	ID17010104PN004_02	Sediment	No	Delist[2]	Current load less than target
Boulder Creek	ID17010104PN032_03	Sediment	No	Delist[2]	Current load less than target
Boulder Creek	ID17010104PN033_02	Sediment	No	Delist[2]	Current load less than target
Boulder Creek	ID17010104PN033_03	Sediment	No	Delist[2]	Current load less than target
Boundary Creek	ID17010104PN002_02	Temperature	Yes	None	NA[3]
Boundary Creek	ID17010104PN002_03	Temperature	Yes	None	NA
Caribou Creek	ID17010104PN017_02	Sediment	No	Delist[2, 4]	Current load less than target
Cow Creek	ID17010104PN006_02	Sediment	Yes	None	NA

Stream	Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Cow Creek	ID17010104PN006_03	Sediment	Yes	None	NA
Deep Creek	ID17010104PN025_02	Temperature	Yes	None	NA
Deep Creek	ID17010104PN022_03	Sediment	Yes	None	NA
Deep Creek	ID17010104PN019_04	Sediment	Yes	None	NA
Deep Creek	ID17010104PN018_04	Sediment	Yes	None	NA
Deep Creek	ID17010104PN015_04	Sediment	Yes	None	NA
Deep Creek	ID17010104PN022_03	Temperature	Yes	None	NA
Deep Creek	ID17010104PN019_04	Temperature	Yes	None	NA
Deep Creek	ID17010104PN018_04	Temperature	Yes	None	NA
Deep Creek	ID17010104PN015_04	Temperature	Yes	None	NA
Moyie River	ID17010105PN001_05	Sediment	No	Delist	Impairment was based on a single event[5]

1. Category 4b contains a list of waterbodies which have water quality improvement projects currently in place.
2. Stressor Identification Assessment (EPA. 2000) performed supports removal of sediment as pollutant.
3. Not Applicable.
4. Caribou Creek within boundary of Deep Creek TMDL.
5. See photos in section *1.2.4.8*.

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1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Subsection 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.)

This document addresses the water bodies in the Lower Kootenai and Moyie River Subbasins that have been placed on Idaho's 1998 §303(d) list.

The overall purpose of the SBA and TMDL is to characterize and document pollutant loads within the Lower Kootenai and Moyie River Subbasins. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Lower Kootenai and Moyie River Subbasins (Section 5).

1.1. Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

1.1.1. Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards).

Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "section 303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. *Kootenai River and Moyie River Total Maximum Daily Loads* provides this summary for the currently listed waters in the Lower Kootenai and Moyie River Subbasin.

The SBA section of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Lower Kootenai and Moyie River Subbasins to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a federally required plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

1.1.2. Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support–cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation–primary (swimming), secondary (boating)
- Water supply–domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when the water body is assessed.

An SBA analyzes and integrates multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

1.1.3. Public Participation and Comment Opportunities

The development of the Kootenai and Moyie river SBA and TMDL included extensive public participation and participation by the Kootenai and Moyie River Watershed Technical Committee and oversight by the Watershed Advisory Group (WAG), Kootenai Valley Resource Initiative.

On May 15, 2006, DEQ initiated a 45 day public comment period for the Kootenai and Moyie River TMDLs that continued to June 23, 2006.

DEQ has complied with the WAG consultation requirements set forth in Idaho Code §39-3611. DEQ has provided the WAG with all available information concerning applicable water quality standards, water quality data, monitoring, assessments, reports, procedures and schedules. Indeed, DEQ worked closely with the WAG in collecting the information for the proposed wasteload allocations (WLAs) and in developing the database that reflects the relevant data.

DEQ utilized the knowledge, expertise, experience, and information of the WAG in developing this TMDL. DEQ also provided the WAG with an adequate opportunity to participate in drafting the TMDL and to suggest changes to the document. Subsequent to the development of the original draft SBA proposed in 2003, the WAG has continued to provide DEQ with input, information, and suggestions for the changes through monthly meetings in 2004 and 2005, and the 45 day public comment period.

1.2. Physical and Biological Characteristics

The Kootenai River originates in Canada, crosses the international border in northwest Montana, and flows through the northwest corner of Montana into Idaho before flowing back into Canada. In Idaho, the Kootenai River flows between the Selkirk Mountains to the west and the Purcell Mountains to the east. The Kootenai River basin in Idaho encompasses 1,007 square miles. The majority of the tributaries in Idaho are orientated in an east-west or west-east aspect. The Kootenai River is the second largest tributary to the Columbia River in volume and third largest in drainage area (18,000 square miles).

Physical and biological characteristics include the climate, which is described briefly below, followed by the characteristics of subbasin, subwatersheds, and streams, all of which are broken down for further discussion.

1.2.1. Climate

The wide range of elevation and topographic features in northern Idaho produce a varied climate. The climate is relatively mild for this latitude, indicating a maritime influence. Prevailing westerly winds originating over the Pacific Ocean influence both the summer and winter temperatures, with a stronger maritime effect on the latter. In winter, the strong winds result in a maritime influence that helps to produce relatively mild conditions. However, on some occasions dry arctic air from Canada spills west of the continental divide producing clear skies and a distinct drop in temperatures. In summer, rainfall, cloud cover, and relative humidity are at their annual minimum due to a weakening of the westerly winds which allows continental climatic conditions to prevail (Abramovich et al. 1998).

The maritime air from the prevailing westerly winds is northern Idaho's major source of moisture. Topography plays a large role in determining how much of that moisture falls as precipitation in a particular area. Weather systems heading east off the Pacific coast encounter north-south mountain ranges, followed by relatively flat areas. These mountain ranges force the moist air to rise and cool, expunging much of the moisture as precipitation. Consequently, high elevations and windward mountain slopes receive more precipitation on average than low elevations and areas on the leeward side of mountain ranges.

Annual average precipitation for the Lower Kootenai Basin in Idaho ranges from about 21 inches near the town of Porthill to over 70 inches along the crest of the Selkirk Mountains. Generally, November, December, and January are the wettest months, while July, August, and September are the driest. The majority of precipitation in the region occurs as snowfall.

1.2.2. Subbasin Characteristics

The subbasin characteristics include hydrology, geology, topography, vegetation, and fisheries and aquatic fauna. Each is discussed in detail below.

1.2.2.1. Hydrology

The Kootenai River (spelled Kootenay in Canada) originates in southeastern British Columbia (Figure 5). From the headwaters, it flows south into Lake Koocanusa, which straddles the border between British Columbia and Montana. Libby Dam, operated by the U.S. Army Corp of Engineers, impounds the river to form the Lake Koocanusa Reservoir. Downstream of the dam, near Libby, Montana, the river turns and flows westward toward Idaho. Near Bonners Ferry, Idaho, the river turns north, and flows again into British Columbia (BC) where it enters Kootenay Lake. From the outlet on the west arm of the lake near Nelson, BC, the river flows westward, through several hydropower impoundments, to its confluence with the upper Columbia River near Castlegar, BC.

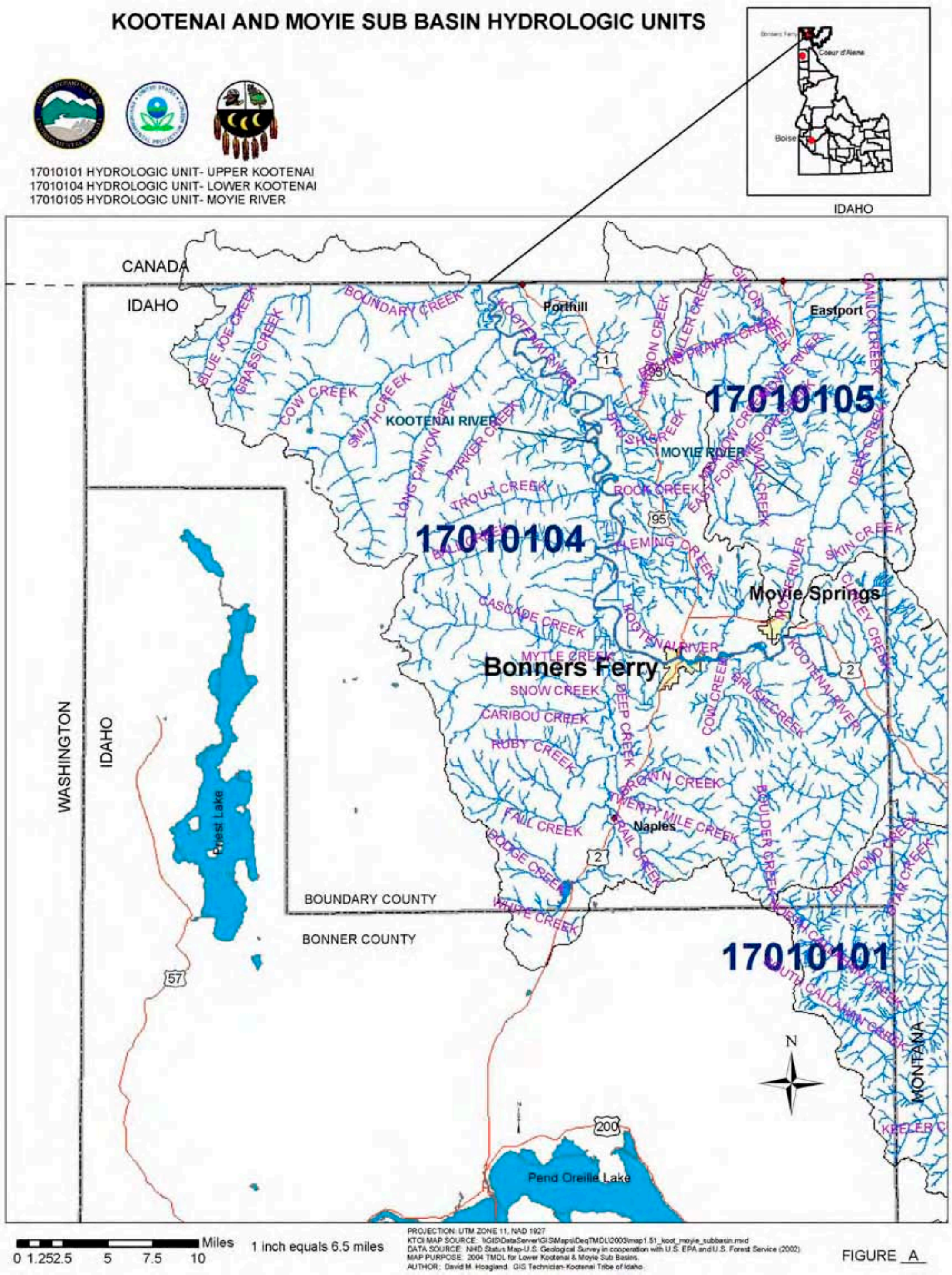

Figure 5. Upper Kootenai, Lower Kootenai, and Moyie River Subbasins in Idaho.

The Moyie River, the largest tributary to the Kootenai River in Idaho, also originates in British Columbia. It crosses the border near Eastport, Idaho, and continues flowing south to where it empties into the Kootenai River near Moyie Springs, Idaho. A hydroelectric project operated by the City of Bonners Ferry dams the river just above Moyie Falls, about 1.5 miles upstream of the mouth.

The Kootenai River in Idaho can be divided into three major reaches with different characteristics. The first 20 km downstream of the Montana state line is primarily a single channel located in a narrow canyon with limited floodplain. This reach is characterized by long runs, with uniform-sized substrate ranging from large gravel to large rubble. There are a few deep pools created by bedrock formations. Aquatic vegetation is rare. The next 10 km of river, immediately above Bonners Ferry, is braided, with several small islands and exposed gravel bars at low flows. Substrates in this reach are generally gravels. The average gradient from Montana to Bonners Ferry is about 0.6 m/km. Below Bonners Ferry, the river flattens to an average gradient of about 0.02 m/km, and begins meandering through the Kootenai Valley, crossing the international border near Porthill. This portion of the river is relatively flat and slow moving, with holes up to 30 m deep. The water level in this reach is affected by operation of the Corra Linn dam on the outlet of Kootenay Lake. The bottom substrate is composed of sand, silt, and clays, with organic materials deposited in eddies and backwaters. Aquatic vegetation is limited and where it is present, it is limited to narrow bands along the shoreline. Dikes have been built on the river banks to prevent flooding of adjacent agricultural lands. Downstream of the border, the river continues its meandering until it enters Kootenay Lake, about 50 km north of Porthill.

The Kootenai River has a mean annual discharge of nine million acre-feet and a flow rate at its mouth of just under 30,650 cubic feet per second (cfs). Mountains in the subbasin receive about 70-80% of their precipitation as snow. The melting of this snowpack during the spring and summer months produces a characteristic “snowmelt hydrograph” in which peak runoff occurs between April and June. Under the terms of the Columbia River Treaty, the U.S. Army Corps of Engineers built Libby Dam in 1973, creating Koocanusa Reservoir (known also as Koocanusa Lake or Libby Reservoir), which spans the Canada-USA border.

Koocanusa Reservoir is a 90-mile-long storage reservoir with a surface area of 188 km2 (46,500 acres) at full pool. It is located upstream from the Fisher River confluence and east of Libby, Montana. The dam has a usable storage of approximately 4,930,000 acre feet and gross storage of 5,890,000 acre feet. The primary benefit of the project is power production. With the five units currently installed, the electrical generation capacity is 525,000 kW. The maximum discharge with all five units in operations is about 26,000 cfs. An additional 1,000 cfs can be passed over the spillway without causing dissolved gas supersaturation problems (USACE 2002). The surface elevation of Koocanusa Reservoir ranges from 2,287 feet to 2,459 feet at full pool. Presently, operations are dictated by a combination of power production, flood control, recreation, and special operations for the recovery of ESA-listed species, including Kootenai River white sturgeon (*Acipenser transmontanus*) and bull trout (*Salvelinus confluentus*) and salmon in the lower Columbia River.

Along with the Libby Dam/Koocanusa Reservoir complex, smaller dams are located on the Elk, Bull, and Goat Rivers on the Canadian side and on the Moyie River and Smith and Lake Creeks in the United States When Kootenay Lake was impounded, the water level increased 7.8 feet, and now the annual drawdown is 9.8 feet. Kootenay Lake stretches 66.4 miles from the tip of its North Arm, near Lardeau, to the tip of its South Arm, near Creston and has a 28 mile-long West Arm jutting from Balfour to Nelson. The total lake covers 150.5 square miles. On average, its depth is 308 feet, and its width 2.3 miles. A total of 56% of the inflow to the lake is regulated by dams. The outflow from the West Arm, near Nelson, is regulated by the Corra Linn Dam (Living Landscapes 2003).

Stream density and water yield are relatively high throughout the basin. The largest Idaho tributary systems include the Moyie River, Deep Creek, Boundary Creek, and Boulder Creek. Many of the tributary streams that enter the Idaho portion of the Kootenai River flow from hanging valleys over bedrock controls, with steep sections and impassable fish barriers. Annual discharge in the Idaho tributaries averages about 2 cfs per square mile of drainage.

The wetlands within Boundary County, Idaho were converted during the early 1900s for agricultural purposes. A network of drainage ditches was completed to establish 16 taxing districts and a few additional drainage districts. A remnant large wetland occurs at the south end of the valley from ancient Mirror Lake. There are two primary U.S. Fish and Wildlife Service wetland designations within the Kootenai River Valley that are identified as palustrine (shallow ponds, marshes, bogs, or swamps) and riverine (rivers, creeks, and streams).

The drainage ditches were excavated into areas which are seasonally flooded areas with persistent hydrophytic vegetation. There are cropland areas within the valley that are temporarily flooded during February and March. These areas are scattered throughout the Kootenai River Valley, typically adjacent to the meanders.

A large permanently flooded wetland exists as Kerr Lake near Copeland. There are natural slough areas (oxbows) or channels adjacent to the river east of Bonners Ferry along Cow Creek road.

The Kootenai River includes wetlands contained within and immediately adjacent to the channel. The system is a permanent perennial open water channel. However, the river has been diked within the floodplain to reduce flooding on agricultural fields. An extensive network of marshes, tributary side channels, and sloughs were formed by lowering of the glacial Kootenay Lake level, flooding, and the river reworking its floodplain. Some of these wetlands continued to be supported by groundwater recharge, springtime flooding, and channel meandering.

1.2.2.2. Geology

The geology of these subbasins is shown in Figure 6 and Figure 7.

The underlying bedrock of the Kootenai River drainage downstream of Libby Dam consists primarily of belt series rock. Intrusions of igneous rock are scattered throughout the area, which has been highly influenced by glacial activity from both continental ice masses and alpine glaciation.

Mountains in the subbasin are composed of folded, faulted, and metamorphosed blocks of Precambrian sedimentary rocks of the Belt Series and minor basaltic intrusions (Ferreira et al. 1992). Primary rock types are meta-sedimentary argillites, sitlites, and quartzites, which are hard and resistant to erosion. Where exposed, they form steep canyon walls and confined stream reaches. The porous nature of the rock and glaciation has profoundly influenced basin and channel morphology (Hauer and Stanford 1997).

During the Pleistocene, continental glaciation overrode most of the Purcell Range north of the river, leaving a mosaic of glacially scoured mountainsides, glacial till, and lake deposits. Late in the glacial period, an ice dam blocked the outlet at the West Arm of Kootenay Lake. The dam formed glacial Kootenay Lake, the waters of which backed all the way to present-day Libby, Montana. Glacial Kootenay Lake filled the valley with lacustrine sediments, which included fine silts and glacial gravels and boulders. A terrace of lacustrine sediments on the east side of the valley is approximately 400 feet above the current floodplain and is a remnant of the ancestral valley floor. Tributary streams working through remnant deposits to meet the present base level of the mainstem and from the mainstem reworking existing floodplain and stream bank deposits continue to be a source of fine sediments.

General soil units are shown in Figure 8 for the Lower Kootenai River Subbasin and Figure 9 for the Moyie River Subbasin. Soil associations, described below, group soils according to broad patterns of soil composition, relief, drainage, and geographic distribution.

The Schnoorson-Ritz-Farnhamton Association includes somewhat poorly drained to poorly drained soils on floodplains and low stream terraces mainly along the Kootenai River. They are level to gently sloping, very deep, silt loams, silty clay loams, and mucky silt loams. Soils of minor extent are DeVoignes, Pywell, and Seelovers. Most of this unit is drained and protected from flooding. It is used for cropland, hay and pasture, or wildlife habitat. The main limitations are a seasonal high water table, hazard of flooding, hazard of soil piping – a type of subsurface erosion that can result in unstable ground and stream bank erosion.

The Rubson-Porthill Association includes well drained to moderately well drained soils on high terraces and benches above the Kootenai River floodplain. They are nearly level to rolling, very deep, silt loams with silt loam to silty clay subsoils. Soils of minor extent are Selle and Elmira. Most of this unit is used for cropland, hay and pasture, woodland, homesites, or wildlife habitat. The main limitations are the hazard of water erosion and a seasonal perched water table in the Porthill soil.

The Selle-Elmira Association includes well drained to excessively drained soils on high terraces and benches above the Kootenai River floodplain. They are nearly level to hilly, very deep, fine sandy loams and loamy fine sands. Soils of minor extent are Rubson. Most of this unit is used for hay and pasture, woodland, cropland, homesites, or wildlife habitat. The main limitations are the hazards of seepage, cutbanks caving, soil droughtiness, and wind erosion.

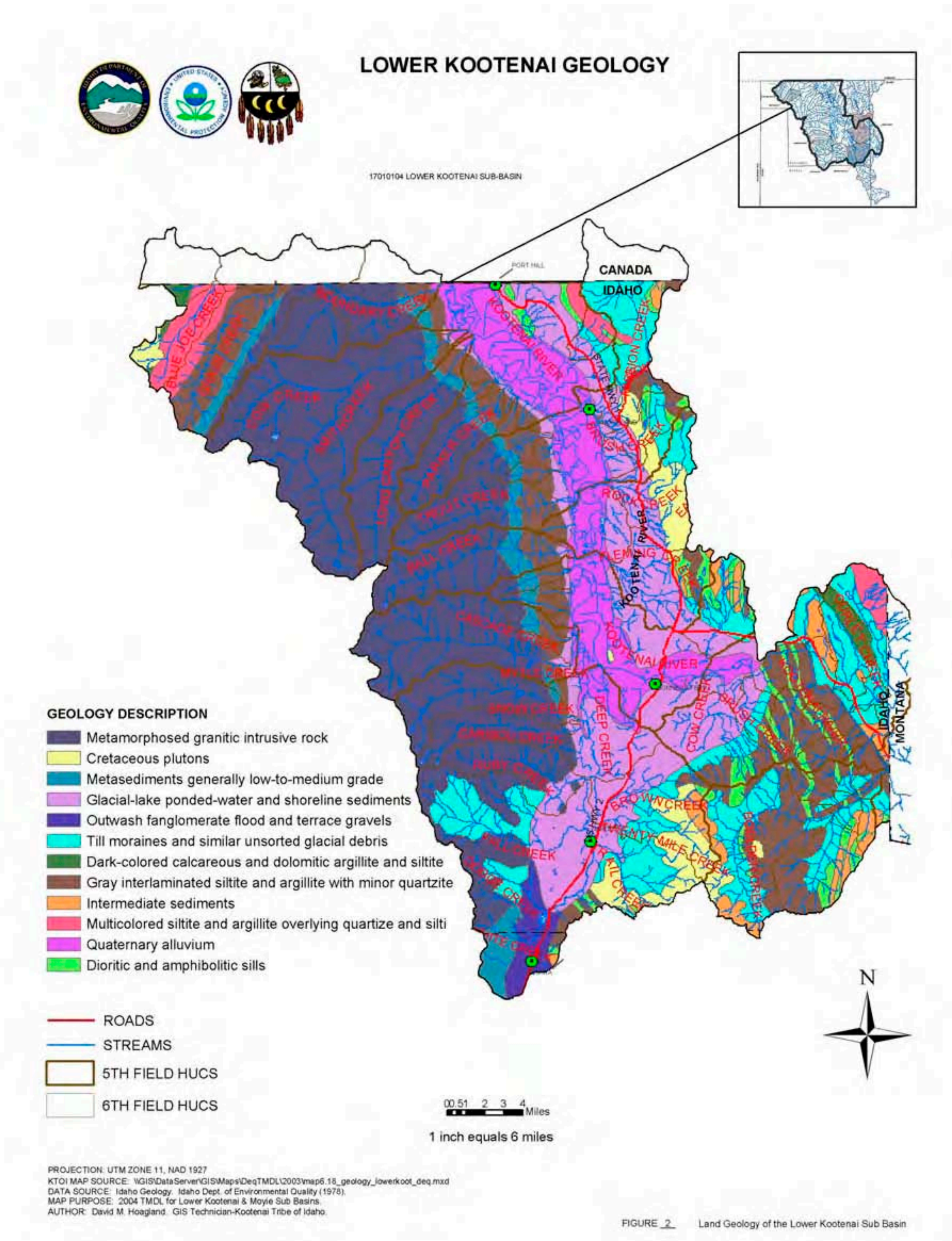

Figure 6. Lower Kootenai River Subbasin geology.

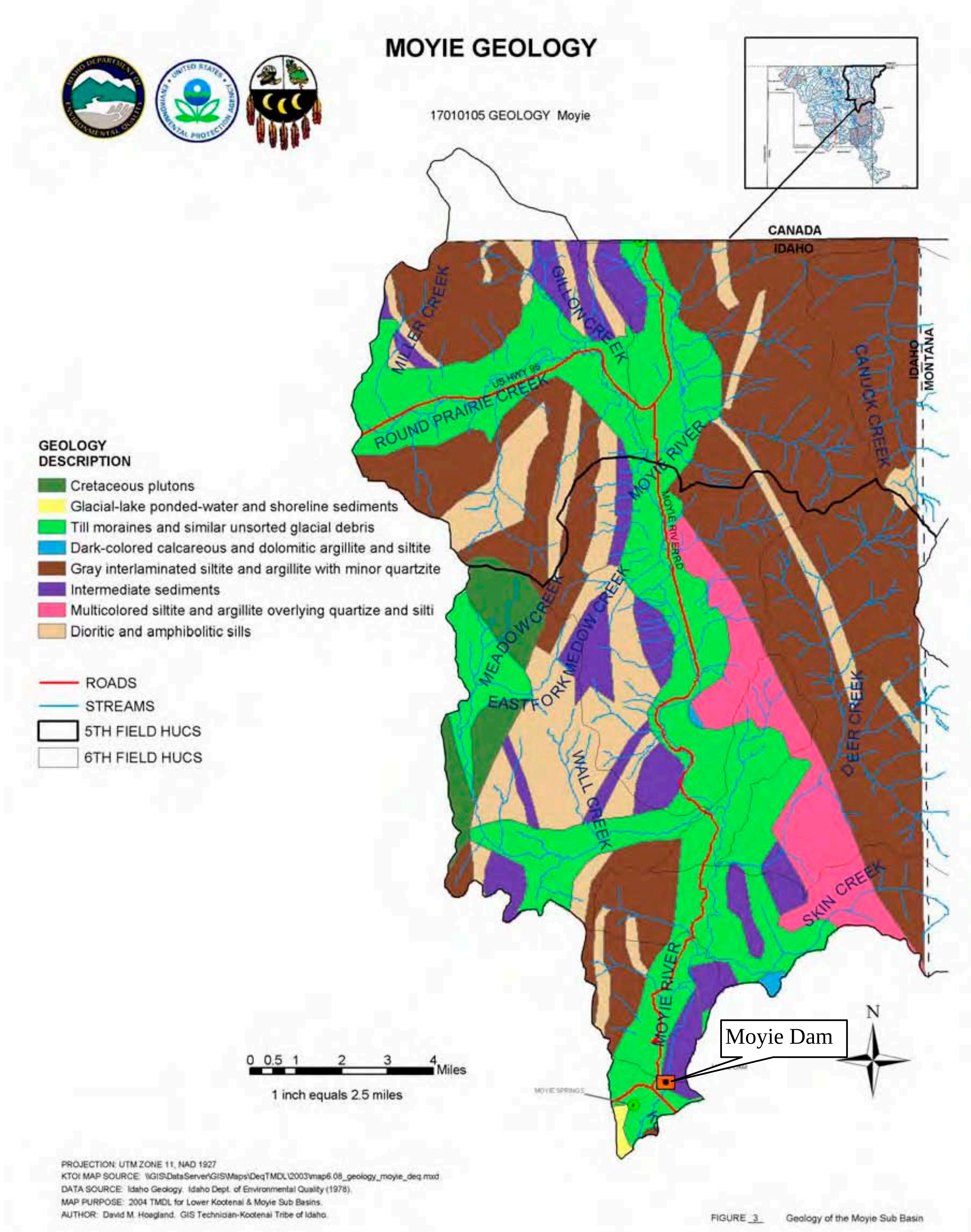

Figure 7. Moyie River Subbasin geology.

The Wishbone-Crash-Artnoc Association includes well-drained soils on terrace escarpments above the Kootenai River floodplain. They are steep to very steep, very deep silt loams. Soils of minor extent are Caboose and Pend Oreille. Most of this unit is used for woodland, livestock grazing, or wildlife habitat. The main limitations are slope, the hazard of water erosion, soil slippage, and soil piping.

The Pend Oreille-Idamont-Rock Outcrop Association includes well-drained soils and rock outcrop on mountains and foothills above the Kootenai River floodplain. They are moderately sloping to very steep, very deep, silt loams high in volcanic ash with gravelly or cobbly sandy loam subsoils. Soils of minor extent are Treble and Kriest. Most of this unit is used for woodland, livestock grazing, wildlife habitat, and recreation. The main limitations are slope, the hazard of seepage, and large stones in some areas.

The Stien-Pend Oreille Association includes well-drained soils on glacial moraines, high terraces, and footslopes above the Kootenai River floodplain. They are nearly level to moderately steep, very deep, silt loams and gravelly silt loams high in volcanic ash with cobbly or very cobbly sandy loam, loamy sand, or sand subsoils. Soils of minor extent are Treble, Selle, and Rubson. Most of this unit is used for woodland, livestock grazing, wildlife habitat, homesites, and recreation. The main limitations are large stones, the hazard of seepage, cutbanks, caving, droughtiness of the Stien soil, and slope in some areas.

1.2.2.3. Topography

Elevations in the Idaho portion of the Lower Kootenai River Subbasin range from peaks over 7,000 feet in the Selkirks down to 1,746 feet where the Kootenai River returns to Canada. The river divides the Selkirk mountain range to the west from the Purcell Mountains to the northeast, and the Cabinet Mountains to the southeast. Of all stream miles in the Lower Kootenai Subbasin, in Idaho, 28% have <2% grade, 23% have 2-6% grade, and 49% have >6% gradient. In the U.S. portion of the Moyie Subbasin, 19% of stream miles are <2% grade, 14% have a 2- 6% grade, and 67% are steeper than 6% grade.

The Federal government has classified nine species of plant and animals that occur within the Lower Kootenai River Subbasin as threatened (T) or endangered (E) under the Endangered Species Act. They include the gray wolf (E), woodland caribou (E), grizzly bear (T), Canada lynx (T), bald eagle (T), bull trout (T), white sturgeon (E), water howellia (T), and Spalding's catchfly (T). The peregrine falcon was formerly listed as endangered but was delisted in 1999. It is now considered recovered subject to five years of monitoring.

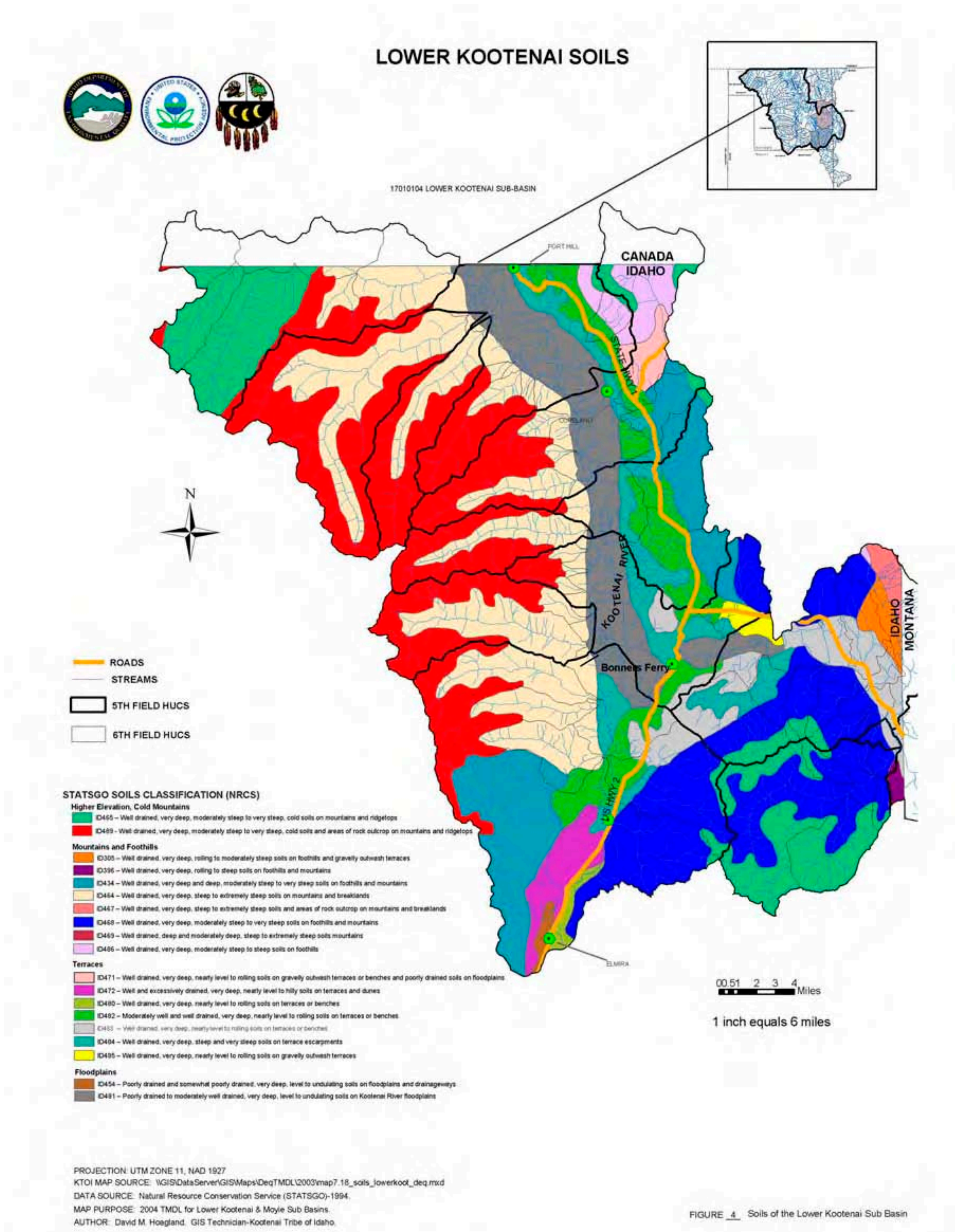

Figure 8. Lower Kootenai River Subbasin soils.

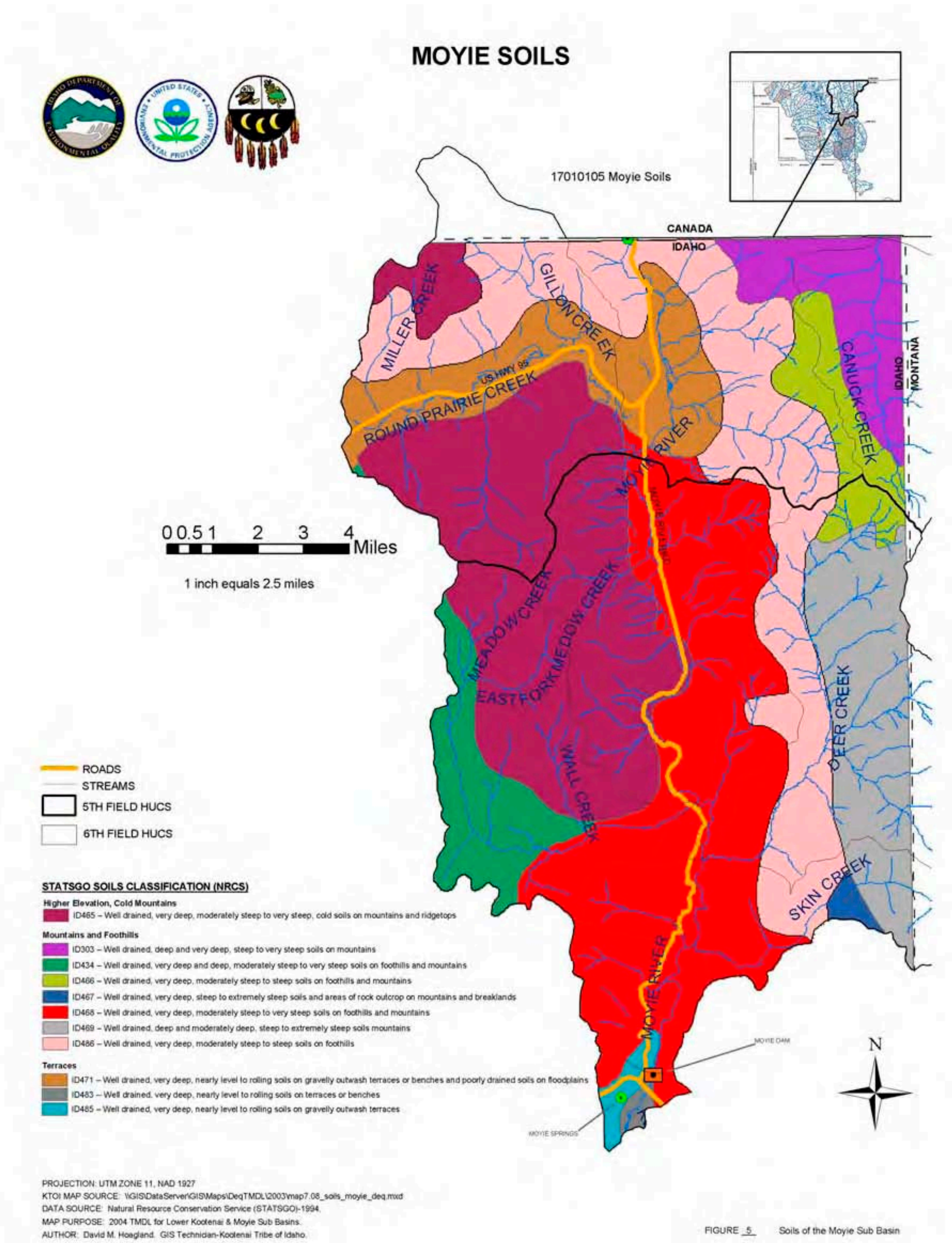

Figure 9. Moyie River Subbasin soils.

1.2.2.4. Fisheries and Aquatic Fauna

There are six native salmonid species in the Lower Kootenai River Subbasin. They are bull trout, (*Salvelinus confluentus*) westslope cutthroat trout (*Oncorhynchus clarki lewisi*), redband rainbow trout (*Oncorhynchus mykiss ssp*.), kokanee salmon (*Oncorhynchus nerka*), pygmy whitefish (*Prosopium coulteri*), and mountain whitefish (*Prosopium williamsoni*). In addition to the endangered white sturgeon (*Acipenser transmontanus*), the Kootenai River also contains Idaho's only population of native burbot (*Lota lota*), a species of special concern. The salmonids, and burbot species are discussed in more detail below.

Distribution of fish species are shown in Figure 10 for the Lower Kootenai River Subbasin and Figure 11 for the Moyie River Subbasin.

Bull Trout

Bull trout (*Salvelinus confluentus*) populations in Idaho may exhibit one of three life history forms: resident, fluvial, or adfluvial. Resident bull trout generally spend their entire life cycle in small headwater streams. Fluvial and adfluvial bull trout spawn in tributary streams where the juveniles rear from one to four years before migrating to either a river system (fluvial) or a lake/reservoir system (adfluvial) where they grow to maturity (Fraley and Shepard 1989). All three life history forms are present in the Lower Kootenai River Subbasin.

Adfluvial bull trout mature at four to seven years of age (Mallet 1969; Pratt 1985; Shepard et al. 1984; Goetz 1989) and may spawn every year or in alternate years (Block 1955; Fraley and Shepard 1989; Pratt 1985; Ratliff 1992). Adfluvial fish grow larger in size and have higher average fecundities than fluvial or resident stocks.

The majority of adfluvial and fluvial bull trout spawning occurs in a small percentage of the total available stream habitat. Spawning takes place between late August and early November, principally in third and fourth order streams. Spawning adults use low gradient areas (< 2%) of gravel/cobble substrate with water depths between 0.1 and 0.6 m and velocities from 0.1 to 0.6 meters per second (m/s). Proximity of cover for the adult fish before and during spawning is an important habitat component. Spawning tends to be concentrated in reaches influenced by groundwater where temperature and flow conditions may be more stable. Spawning habitat requirements of resident bull trout are poorly documented.

Successful incubation of bull trout embryos requires water temperatures below 8 °C, less than 35-40% of sediments smaller than 6.35 mm in diameter, and high gravel permeability. Eggs are deposited as deep as 25.0 cm below the streambed surface and the incubation period varies depending on water temperature. Spawning adults can alter streambed characteristics during redd construction to improve survival of embryos, but conditions in redds often degrade during the incubation period. Mortality of eggs or fry can be caused by scouring during high flows, freezing during low flows, superimposition of redds, or deposition of fine sediments or organic materials. A significant inverse relationship exists between the percentage of fine sediment in the incubation environment and bull trout survival to emergence. Entombment is likely a significant mortality factor during incubation. Groundwater influence plays a large role in embryo development and survival by mitigating mortality factors.

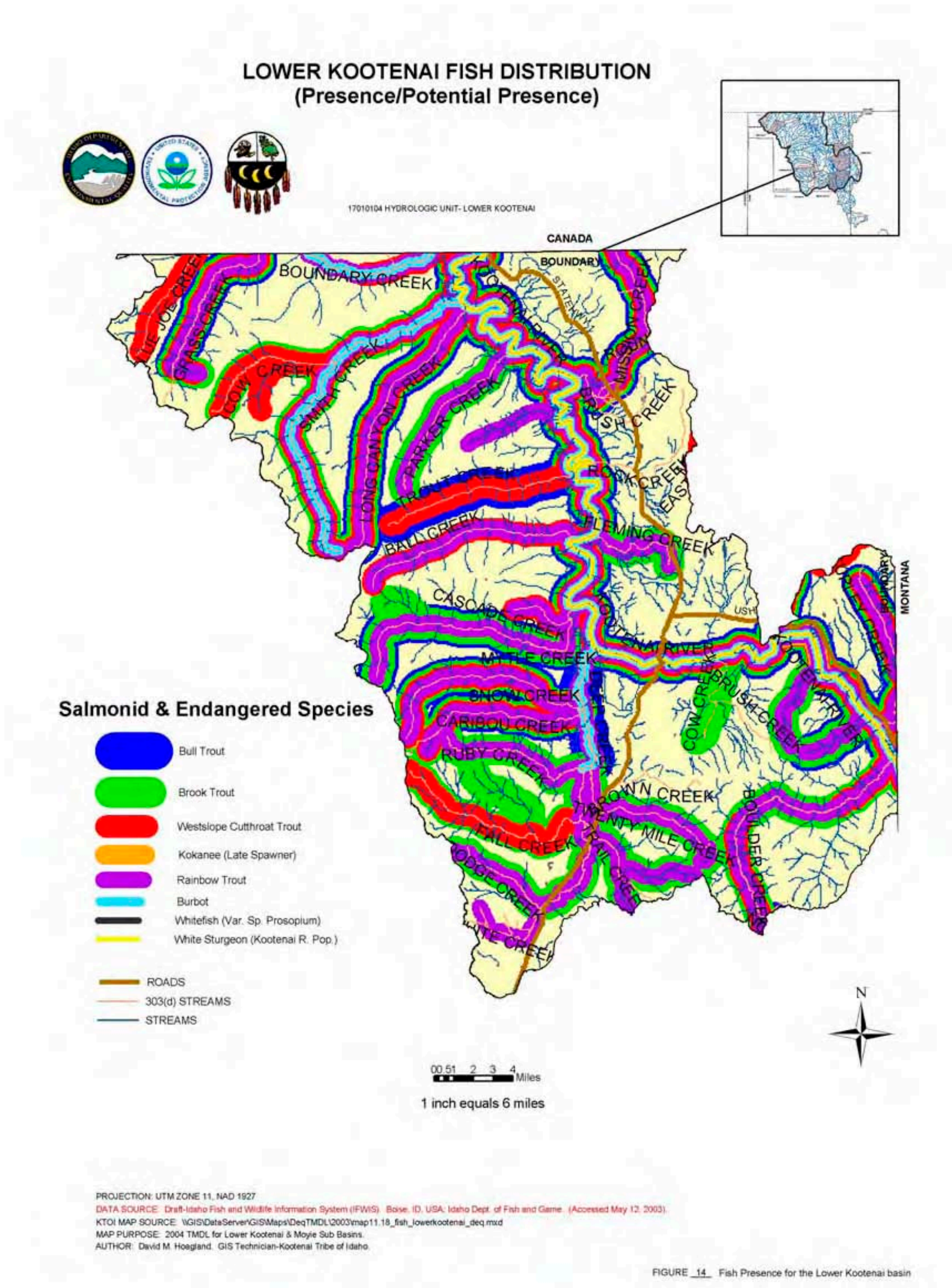

Figure 10. Distribution of fish species in the Lower Kootenai River Subbasin.

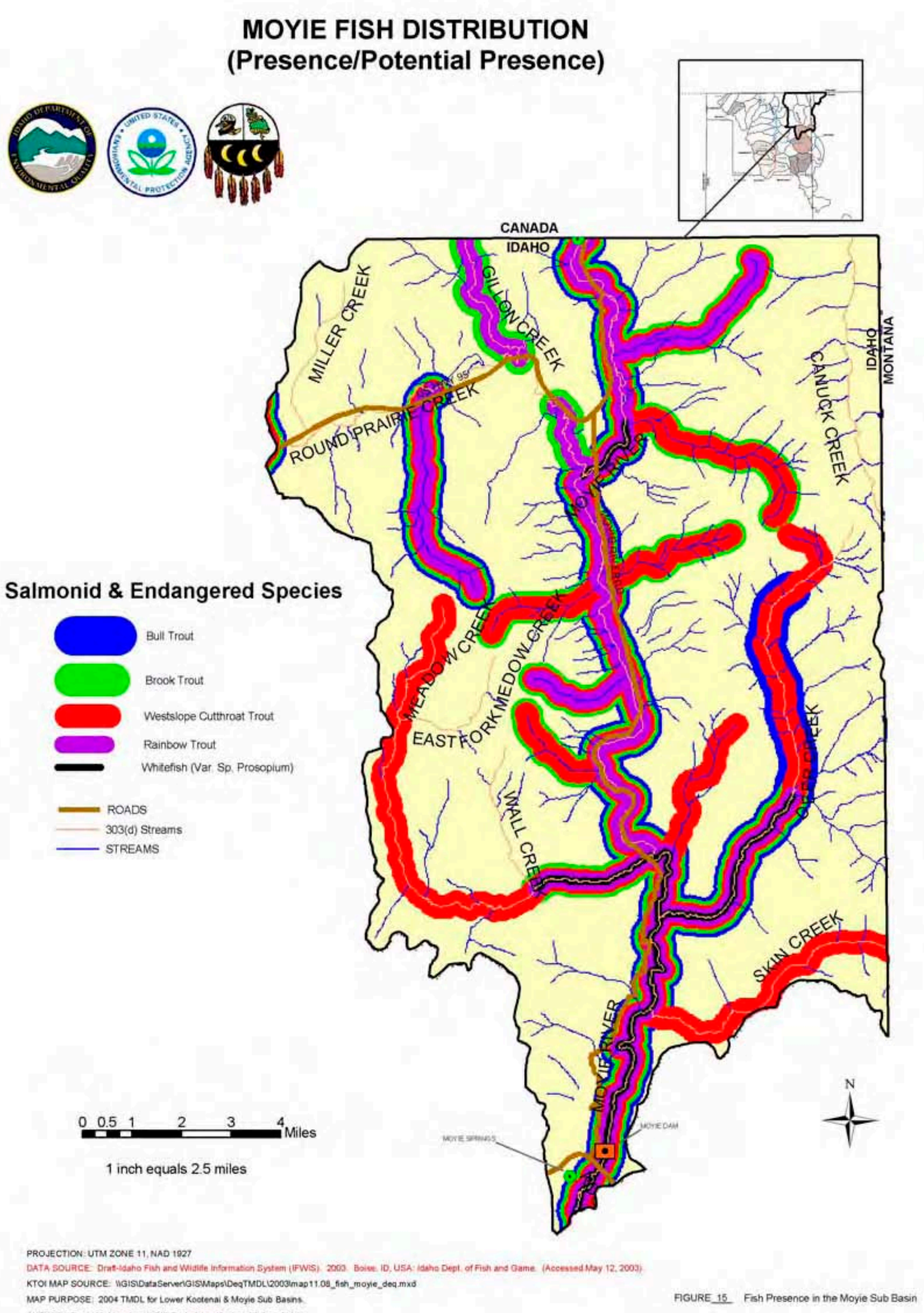

Figure 11. Distribution of fish species in the Moyie River Subbasin.

Rearing habitat requirements for juvenile bull trout include cold summer water temperatures (15 °C) provided by sufficient surface and groundwater flows. Warmer temperatures are associated with lower bull trout densities and can increase the risk of invasion by other species that could displace, compete with, or prey on juvenile bull trout. Juvenile bull trout are generally benthic foragers, rarely stray from cover, and prefer complex forms of cover. High sediment levels and embeddedness can result in decreased rearing densities. Unembedded cobble/rubble substrate is preferred for cover and feeding, and also provides invertebrate production. Highly variable streamflow, reduction in large woody debris, bedload movement, and other forms of channel instability can limit the distribution and abundance of juvenile bull trout. Habitat characteristics that are important for juvenile bull trout of migratory populations are also important for stream resident subadults and adults. However, stream resident adults are more strongly associated with deep pool habitats than are migratory juveniles.

Both migratory and stream-resident bull trout move in response to developmental and seasonal habitat requirements. Migratory individuals can move great distances (up to 250 km) among lakes, rivers, and tributary streams in response to spawning, rearing, and adult habitat needs. Stream-resident bull trout migrate within tributary stream networks for spawning purposes, as well as in response to changes in seasonal habitat requirements and conditions. Open migratory corridors, both within and among tributary streams, larger rivers, and lake systems are critical for maintaining bull trout populations.

Westslope Cutthroat Trout

The distribution and abundance of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) has declined from historic levels across its range, which includes western Montana's Kootenai River drainage (Liknes and Graham 1988). Westslope cutthroat trout persist in only 27% of their historic range in Montana. Due to hybridization, genetically pure populations are present in only 2.5% of that range (Rieman and Apperson 1989). Introduced species have hybridized or displaced westslope cutthroat trout populations across their range. Hybridization causes loss of genetic purity of the population through introgression. Some remaining genetically pure populations of westslope cutthroat trout are found above fish passage barriers that protect them from hybridization, but isolate them from other populations. Westslope cutthroat trout are common in the Kootenai National Forest.

Brook trout are believed to have displaced many westslope cutthroat trout populations (Behnke 1992). Where the two species co-exist, westslope cutthroat trout predominate in higher gradient reaches and brook trout prevail in lower gradient reaches (Griffith 1988). This isolates westslope cutthroat trout populations, further increasing the risk of local extinction from genetic and stochastic factors (McIntyre and Rieman 1995).

Westslope cutthroat trout exhibit both the migratory and resident life histories on the Kootenai National Forest. Westslopes are capable of traveling over 100 miles during spawning migration. Migratory fish typically rear in their natal streams until their third year, at a length of 7-9 inches, when they migrate to either a larger stream or lake to rear to maturity. Resident fish are significantly smaller than their migratory counterparts. Sexual maturity is attained at either age four or five, at lengths of 4-16 inches, at which time these fish migrate back to their natal streams to spawn. Westslopes can typically reach lengths in excess of 20 inches and weigh in excess of three pounds. Common lifespan for this species is seven years. Westslopes feed primarily on aquatic insects in streams and larger zooplankton in lakes.

Westslope cutthroat occur in about 1,440 linear miles of stream habitat in the U.S. portion of the Lower Kootenai River Subbasin. Abundance data are available for 1,051 of those stream miles. Approximately 70 percent of those have stocks that are considered abundant. Data for the Montana portion of the Kootenai River Basin from the Interior Columbia Basin Ecosystem Management Project indicate westslope cutthroat trout stocks are strong or predicted strong in 15 HUCs, depressed or predicted depressed in 159 HUCs, and absent or predicted absent in the remaining 11 HUCs. In the Idaho portion of the Kootenai River Basin, westslope cutthroat trout presence is known or predicted in 41 HUCs and absent in two. Westslope cutthroat trout status is known or predicted strong in four HUCs and known or predicted depressed in 37 HUCs.

Shepard and others (2003) reported that among the streams surveyed in the U.S. portion of the Lower Kootenai Subbasin, stocks of unintrogressed (i.e., not demonstrating genetic influences from other species) cutthroat trout occupied 142.5 miles; stocks that are less than 10% introgressed occupied 29.5 miles; stocks between 25% and 10% introgressed occupied 86.3 miles; and stocks greater than 25% introgressed occupied 576.5 miles. Westslope cutthroat trout stocks inhabiting 197.1 miles of stream are suspected to be unintrogressed (with no record of stocking or contaminating species present), and stocks inhabiting 1,498 miles are potentially altered (potentially hybridized with records of contaminating species being stocked or occurring in stream).

The Montana Chapter of the American Fisheries Society (MTAFS) identified over exploitation, genetic introgression and competition from nonnative fish species, and habitat degradation as three primary reasons for the decline of westslope cutthroat trout in Montana.

In a HUC-by-HUC assessment of all Kootenai River Subbasin 6th field HUCs in the U.S., a technical team concluded that of the habitat attributes considered most important to resident salmonids, the most limiting for westslope cutthroat trout when averaged across all the HUCs in the U.S. portion of the subbasin are riparian condition, fine sediment, channel stability, and habitat diversity, in that order. In the Canadian portion of the subbasin they are riparian condition, habitat diversity, channel stability, and fine sediment.

Redband Trout

The redband trout (*Oncorhynchus mykiss*) is a widely distributed western North America native salmonid. Resident interior redbands can be further divided into two forms – the adfluvial interior redband or "Kamloops rainbow" and others, which annually migrate between a lake and tributary river in order to complete their lifecycles, and the fluvial interior redband, which remain in a river system throughout its life (Moyle et al. 1989). The potential for both exists in the Upper Kootenai Subbasin.

The historic range of the interior redband included freshwaters west of the Rocky Mountains, extending from northern California to northern British Columbia, Canada (Behnke 1992). Presently the only population of pure strain redbands occurs in the Upper Kootenai Subbasin in Callahan Creek near the Montana and Idaho border.

Redbands spawn in the spring, from March through June (Kunkel 1976). Fry emerge from the stream-bottom approximately two months after spawning and begin a stream residence that may last one-year to a lifetime (Scott and Crossman 1973). Adfluvial and migratory fluvial redband juveniles will typically move downstream to their ancestral lake or river after one to three years of residence in the headwaters. Sexual maturity typically occurs at three to five years except in cold or hot climates where life expectancy is shortened. Where native interior redbands and westslope cutthroat occur in the same habitats, the two species appear to have evolved strategies to limit introgression as evidenced in the Yaak River tributaries.

The subspecies is known to occupy waters between 700 and 1,500 meters in elevation (D. Perkinson, personal communication). The distribution of the subspecies may be influenced by watershed productivity, presence of barriers, channel hydraulics, distribution of prey species, possibly large-river fluvial forms, suitable riparian overstory cover, and substrate conditions.

Interior redband have been found in watersheds as small as five square kilometers, but the subspecies is generally known from far more productive waters where piscivory supports fish up to 35 pounds (Perkinson 1995; Scott and Crossman 1973). Nearly every pure strain population is found upstream of barriers. Redbands select riffle habitats with an apparent preference for cobble substrates and boulder formed small in channel pools in summer (Kunkel 1976; D. Perkinson, personal communication).

One species that presents substantial threat to redbands is the coastal rainbow. The widespread culture and stocking of coastal rainbow stocks, or hybrid redband, steelhead, and rainbow, throughout the redband's range, has led to substantial losses of the native genotype (Behnke 1992; Campton and Johnston 1985).

The status of Montana redband trout populations is presumed to be stable (J. Dunnigan, Montana Fish and Wildlife, personal communication 2004). In the Idaho Panhandle National Forest, little is known about the status of Kootenai-drainage redband trout populations. In all but five of the 6th-field HUCs in the Idaho portion of the Kootenai River watershed, the redband trout status is described by the United States Forest Service (USFS) as "presence unknown." In three HUCs, redbands are known to be present but their population status is unknown, and in two they are present but depressed. PWI (1999) reports that the rainbow trout population in the lower Kootenai River itself (downstream of Kootenai Falls) may be the strongest stock of all the salmonids, but that the genetic integrity of the native interior redband has been significantly compromised through stocking of non-native rainbow strains and hybridization with cutthroat trout. An assessment of Kootenai Subbasin 6th-field HUCs concluded the most limiting habitat attributes for redband trout in U.S. tributaries are riparian condition, fine sediment, high temperature, and channel stability, in that order.

In the mainstem, the most limiting factors were altered hydrograph due to Libby Dam, riparian condition, elevated temperature, and fine sediment. In the Canadian portion of the subbasin, the most limiting habitat attributes include riparian condition, channel stability, fine sediment, and habitat diversity. The rankings vary at the fourth field watershed scale. Biological limiting factors in U. S. tributaries include non-native species, system productivity, and connectivity between the mainstem and tributaries. Biological limiting factors in the U. S. mainstem include non-native species and system productivity. In lakes, the most limiting attributes are hydraulic regime, migratory obstructions, shoreline condition, and temperature.

Kokanee Salmon

From a subbasin perspective, most kokanee (*Oncorhynchus nerka*) populations appear relatively stable and abundant, bearing in mind that the impacts of the Duncan and Libby dams were never fully assessed. Therefore, pre-dam population levels are unknown. Abundance is a relative term, with today's observations of abundance most likely considered sparse by previous generations of Native Americans and early Europeans. There are currently six populations of kokanee in the Kootenai River Subbasin in Idaho, Montana, and British Columbia.

Native kokanee salmon runs in lower Kootenai River tributaries in Idaho have experienced dramatic population declines during the past several decades (Ashley and Thompson 1993; Partridge 1983). The kokanee that historically spawned in these tributaries inhabited the South Arm of Kootenay Lake in British Columbia. Native kokanee are considered an important prey item for white sturgeon and also provided an important fishery in the tributaries of the lower Kootenai River (Partridge 1983; Hammond, J., B.C. MELP, personal communication 2000). Kokanee runs into North Idaho tributaries of the Kootenai River that numbered into the thousands of fish as recently as the early 1980s have now become "functionally extinct" (Anders 1993; Kootenai Tribe of Idaho, unpublished data). Since 1996, visual observations and redd counts in five tributaries found no spawners returning to Trout, Smith, and Parker Creeks, while Long Canyon and Boundary Creeks had very few kokanee returns.

In a HUC-by-HUC assessment of all Kootenai Subbasin 6th-field HUCs in the U.S., the technical team concluded that of the habitat attributes considered most important to resident salmonids, the most limiting for kokanee, when averaged across all the HUCs in the U.S. portion of the subbasin, were low flow, channel stability, high flow, and fine sediment, in that order. In the Canadian portion of the subbasin they were channel stability, fine sediment, riparian condition, habitat diversity. In the lakes assessed, the limiting factors were hydraulic regime, volumetric turnover rates, migratory obstructions, and trophic status.

Burbot

The burbot (*Lota lota*) is common in the upstream reaches of the Columbia River Basin in the northwestern U.S. and Canada. In Idaho, burbot are endemic only to the Kootenai River, while they also occur in this same river system as well as Kootenay Lake in British Columbia. The Kootenai River and Kootenay Lake once provided popular sport, subsistence, and commercial fisheries for burbot. However, soon after Libby Dam became operational and Lake Koocanusa was formed, in 1972, the respective burbot fisheries in the Kootenai River, Idaho and Kootenay Lake, British Columbia, diminished significantly. Several changes have occurred on the Kootenai River, but the most serious impact is thought to be Libby Dam, constructed by the U.S. Army Corps of Engineers for hydropower and flood control. Shortly after the dam became operational, the fishery in Kootenay Lake rapidly diminished from an annual harvest of over 26,000 burbot in 1969 to none in 1987. Angling regulations for burbot fishing in both bodies of water became more restrictive, but the fisheries did not improve; both fisheries were eventually closed. The main reasons for the loss of both fisheries are believed to be high winter flows during the traditional spawning period for burbot, loss of nutrients to the impoundment created by Libby Dam, and warmer winter temperatures. Fisheries and river managers joined as a Kootenai River Burbot

Conservation Committee to formulate a conservation strategy to prevent further losses and identify actions needed to rehabilitate the burbot population. These conservation strategies propose measures that are thought necessary for the rehabilitation of burbot in the lower Kootenai River; measures include ecosystem rehabilitation, modification of the present flood curves to reduce flow during the winter migration and spawning season for burbot, the use of behaviorally and genetically similar donor stocks, confined brood stocks, burbot culture, an additional turbine on Libby Dam, and spring management of Kootenay Lake elevation. Rehabilitation of the burbot population is believed more likely if all of the measures are implemented and the process is facilitated through managing agencies with public involvement.

The burbot, locally referred to as the "ling" or "ling cod", is the only freshwater member of the cod family. Burbot are typically associated with larger streams or rivers and deep, cold lakes or reservoirs. Historically, they inhabited the mainstem Kootenai River and a few of its tributaries. Recent research below Libby Dam estimates the current population in that area to be near 1,000 individuals (range 680-1,700).

Although spawning has been confirmed below Libby Dam, it is not known if burbot spawn below Kootenai Falls in Montana.

Burbot may also occur in the Yaak River below Yaak Falls. Distribution of burbot is limited to the Kootenai River on the Kootenai and Idaho Panhandle National Forests. Burbot are a cold-water, bottom-dwelling species. Burbot are eel-like with marbled body coloration from dark olive to brown on the back contrasted with brown or black; the sides are lighter than the back; and the belly is yellowish white (Simpson and Wallace 1982). Burbot have a distinguishing single slender barbel on the chin. In the lower Kootenai River, burbot can weigh up to 10 pounds and live up to 15 years.

Burbot that occur in the Kootenai River basin exhibit three life history strategies in several potentially isolated groups. The burbot that constitute the lower Kootenai River population spend a portion of their life in the South Arm of Kootenay Lake, and then migrate up the Kootenai River during the winter months to spawn in the mainstem river or tributary streams in British Columbia or Idaho (an adfluvial life form, i.e., one that migrates from lake to river and tributary streams for spawning). Kootenai Falls in Montana, present for approximately 10,000 years, physically isolates this population of burbot from the population that occurs above the falls (Paragamian et al. 1999). Burbot above the falls are believed to spend their entire lives in the river system (a fluvial life form, i.e., one that spends its entire life in the river or migrates from river to tributary streams for spawning). A burbot population also exists in Lake Koocanusa, a reservoir formed when Libby Dam was constructed near Libby, Montana, in the early 1970s.

Under natural conditions, burbot in the Kootenai River basin spawn under ice during the winter months in water temperatures below 4°C (39 °F) (Simpson and Wallace 1982). Spawning commences in early February and lasts two to three weeks.

Most information suggests that river spawning burbot prefer low velocity areas in main channels or in side channels behind deposition bars, with the preferred substrate consisting of fine gravel, sand, or silt (Fabricius 1954 in McPhail and Paragamian 2000; McPhail and Paragamian 2000). Spawning is also known to occur in small tributary streams and is generally believed to take place at night (Simpson and Wallace 1982; McPhail and Paragamian 2000).

Female burbot are larger than males and, depending on their size, may produce between 50,000 and 1,500,000 eggs (Simpson and Wallace 1982). Male burbot typically reach sexual maturity in three to four years, with females maturing in four to five years (BRS, in draft). During spawning, burbot typically collect in a large mass referred to as a spawning ball, with one or more females in the center surrounded by many males (Simpson and Wallace 1982; McPhail and Paragamian 2000). There is no site preparation during spawning, and eggs are broadcast into the water column well above the substrate. The eggs are semi-buoyant and eventually settle into cracks in the substrate. Newly hatched burbot drift passively in open water until they develop the ability to swim (McPhail and Paragamian 2000). Young burbot initially select shoreline areas among rocks and debris for feeding and habitat security.

Burbot prefer cold water and, during summer months, move to the hypolimnion (lower zone of a thermally stratified lake) areas of lakes or deep-water pools of large rivers (Simpson and Wallace 1982). Feeding is mostly done at night, with adult burbot feeding almost exclusively on fish. Young burbot feed on a variety of aquatic organisms, such as insects, amphipods, snails, and small fish (Simpson and Wallace 1982). Burbot are most active in the winter when they move great distances to spawn, but are rather sedentary during the non-spawning seasons.

The lower Kootenai River once supported a significant number of burbot and provided an important winter fishery to the region. Although declines in burbot numbers in Idaho and British Columbia had been documented as early as 1959, they were still considered relatively stable through the 1960s. Despite fishery regulations implemented in the 1970s, the burbot populations in the Idaho and British Columbia portion of the basin declined after the construction of Libby Dam in 1972. Only 145 adult burbot have been captured in the Kootenai River in Idaho and British Columbia since 1993 (Paragamian et al. 1999). Spawning was known to occur in many tributary streams in Idaho and likely occurred in the river (BRS, in draft). However, recent studies reveal scant evidence of burbot reproduction in Idaho, as no larval fish and only one juvenile fish have been captured since 1993 (Paragamian and Whitman 1999). Currently, the only tributary known to support spawning burbot is the Goat River, which is just north of the Idaho border in British Columbia (Paragamian 1995a; Paragamian, in draft).

Prior to the diminishment of the lower Kootenai River burbot population in the 1970s, anglers reported catching more than 40 burbot a night during the winter using setlines. The estimated annual harvest for the sport and commercial fishery was in the tens of thousands of kilograms or several thousand fish annually (BRS in draft; Paragamian, personal communication 2000). However, the annual harvest of burbot between 1979 and 1983 was estimated at about 250 fish. With continued declines, both BC and Idaho fisheries were closed in the 1990s.

Declines in lower Kootenai River burbot appear to be most strongly associated with habitat modification resulting from the construction and operation of Libby Dam (Paragamian 1993; Paragamian et al. 1999). Temperature and flow changes that alter spawning patterns and poor fry survival due to a reduction in food productivity in the river are believed to be the primary threats to burbot (Paragamian 1993; Paragamian and Whitman 1998; Paragamian et al. 1999).

In addition to flow change, winter water temperature has increased by 4 to 5 °F (2 to 3°C) since the construction of Libby Dam. This temperature increase is believed to influence the activity level and location of burbot during the pre-spawn migration. Prior to the construction of Libby Dam, many portions of the lower Kootenai River would freeze allowing burbot to spawn under ice in water temperatures between 34 and 37°F (1 and 3°C) (Becker 1983 in Paragamian 1995a). Lower Kootenai River temperatures are now 39 to 41°F (4 to 5°C) during the winter months and many sections no longer freeze over (Paragamian 1995a).

The decline in the productivity of the Kootenai River and in Kootenay Lake following the construction of Libby Dam may also be linked to the decline of burbot. Sediment and nutrients settle behind Libby Dam in Lake Koocanusa and reduce the nutrient loading to the river. Analyses of macrozooplankton in the lower Kootenai River indicated that there is a scarcity of important foods such as Daphnia, Diaphanosoma, and Cyclops (Paragamian 1995b).

In the summer of 2005 The Kootenai Tribe of Idaho, in conjunction with The Idaho Department of Fish and Game, began the Kootenai River Nutrient Addition Project. The goal of the project is to reverse the effects of depleted nutrients in the Kootenai River. Nutrient addition outfall is located west of the Idaho/Montana border, and anticipated to treat 17 miles of river from the Idaho/Montana border to Bonner's Ferry, ID. Addition of nutrients is hypothesized to stimulate food web production and help restore populations of trout, kokanee, mountain whitefish and the endangered burbot and white sturgeon (Hardy and Holderman).

Nutrient discharge amounts from the project are flow dependant and will occur between June 1st and September 30th. Discharge must consist of ammonium polyphosphate and urea ammonium nitrate at a flow rate and concentration necessary to achieve an approximate soluble reactive phosphorous concentration of 3ug/L and nitrate nitrite concentrations of 30-50ug/L in the Kootenai River downstream of the discharge. The nutrient addition project must adhere to strict monitoring protocols and results of sampling must be reported to EPA each month during operation.

1.2.3. Subwatershed Characteristics

The Lower Kootenai River Subbasin in Idaho consists of roughly eighteen subwatersheds and a few minor first order tributaries to the Kootenai River. Portions of eleven of the eighteen subwatersheds lay either in Canada or Montana.

1.2.4. Stream Characteristics

Streams in the Idaho portions of the Lower Kootenai and Moyie River Subbasins generally have steep gradients with riffle dominated morphologies. Streams not contained in the floodplain are high energy, moderately entrenched, and in places, cascading. Tributaries within the Kootenai River floodplain are generally low gradient, riffle/run and meandering. Smaller tributaries entering the Kootenai and Moyie Rivers are generally orientated in an east-west or west-east direction. Following are more detailed descriptions of Deep Creek, Boundary Creek, Cow Creek, Blue Joe Creek, Boulder Creek, Caribou Creek, and the Moyie River in Idaho

1.2.4.1. Deep Creek

Deep Creek is a 116,760-acre watershed in the southwest corner of the Lower Kootenai River Subbasin. Deep Creek debouches into the Kootenai River approximately three miles downstream from Bonners Ferry. Major tributaries within the Deep Creek drainage include Brown Creek, Twentymile Creek, Trail Creek, Dodge Creek, Fall Creek, Ruby Creek, Caribou Creek, and Snow Creek. The drainage is oriented in a northerly direction with side tributaries entering mostly from the west and east. Average precipitation across the Deep Creek watershed is 36 in/yr. Mean annual discharge from the creek is 336 cfs. High-volume runoff occurs during spring snowmelt and major rain-on-snow events.

The Deep Creek drainage is predominantly underlain by glacial till, coarse textured alluvium, highly and weakly weathered Belt Supergroup metasediments, and highly weathered and weakly weathered granitics of the Kaniksu Batholith. These highly and weakly weathered rocks are typically divided, with the highly weathered material occurring along the lower elevations and the weakly weathered material occupies the uplands and ridgelines.

Much of the low lying floodplain is dominated by grasslands and mixed conifer/broadleaf vegetation types. Forested riparian areas along floodplains typically support mixed grasses, forbes, broadleaf and needleleaf hydrophilic species. South to west facing slopes at lower elevations support stands of ponderosa pine, lodgepole pine, and Douglas fir vegetation types. As side slope elevation increases forest stands generally become denser with a greater number of coniferous species. The presence of Douglas fir, grand fir, western hemlock, western red cedar, western larch, western white pine, and subalpine fir increases with increasing elevation and effective precipitation.

Ownership within the Deep Creek watershed is mixed. The United States Forest Service (USFS), Idaho Department of Lands (IDL), Forest Capital, and Stimson Lumber Company all manage sections of timber land, mostly in the higher elevations of the watershed. Lowlands are primarily privately owned, and include areas of forest, wetlands, agriculture, and residential development. Part of the Kootenai National Wildlife Refuge lies adjacent to the lower end of Deep Creek.

1.2.4.2. Boundary Creek

Boundary Creek is a third order tributary located in north Idaho and flows parallel to the Idaho/Canada international border. Boundary Creek flows into the Kootenai River approximately 100 meters north of the international border. Major tributaries to Boundary Creek include Blue Joe Creek, Grass Creek and Saddle Creek. For the purpose of this assessment, the portions of Boundary Creek referenced are from the Idaho/Canadian border to Idaho/Canadian border, west to east. Land within the United States portion of the watershed is publicly owned and managed by the USFS.

Boundary Creek is orientated in a west-east direction with a dendritic stream feeder pattern to the Kootenai River. Elevation in the watershed ranges from 3,400 feet above sea level where the creek enters Idaho from Canada to 1,760 feet above sea level were the creek enters back into Canada.

The Boundary Creek drainage is predominantly underlain by weakly weathered granites of the Kaniksu Batholith. The area is characterized by warm, dry summers and cold, wet winters. The majority of the precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. The majority of the watershed is vegetated by coniferous species.

1.2.4.3. Cow Creek

Cow Creek is a 13,528-acre watershed in north Idaho and is entirely contained in Boundary County. Lower portions of the watershed are forested while the upper portion of the watershed is an area of historic burn and is now managed as a cattle grazing allotment. For the purposes of this assessment, Cow Creek, along with major and minor tributaries are all combined and referred to in this report as Cow Creek. Cow Creek flows into Smith Creek approximately 7.5 miles upstream from the Smith Creek confluence with the Kootenai River.

Land ownership is primarily public and managed by the USFS. A small portion of the watershed along the Selkirk Crest is managed by the IDL. Privately owned land does exist in the watershed on a limited basis.

Cow Creek is a second order tributary, with a dendritic stream feeder pattern to Smith Creek. The watershed is orientated in a westerly direction with tributaries entering from the north and south. Elevation in the watershed ranges from 3,560 feet above mean sea level where Cow Creek merges with Smith Creek to 6,893 feet above mean sea level.

Cow Creek drainage is predominantly underlain by weakly weathered granites of the Kaniksu Batholith. The area is characterized by warm, dry summers and cold, wet winters. The majority of the precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. The majority of the watershed is vegetated by coniferous species.

1.2.4.4. Blue Joe Creek

Blue Joe Creek is a 6,002-acre forested watershed located in north Idaho and entirely contained in Boundary County. For the purpose of this assessment, Blue Joe Creek, along with major and minor tributaries, are all combined and referred to in this report as Blue Joe Creek. Blue Joe Creek is orientated in a northerly direction with the headwaters and majority of the watershed located in the United States. Blue Joe Creek is a second order tributary to Boundary Creek after flowing north and crossing the United States/Canada international border.

Land ownership is primary public with a small section of privately owned land located near the headwaters of Blue Joe Creek. Publicly owned land in the watershed is managed by the United States Forest Service. Privately owned land in the watershed is confined to the area of the historic Continental Mine site. The Continental Mine was a silver mine in operation from the 1890s to the 1950s. Silviculture activities exist within the watershed on a limited basis.

Blue Joe Creek is a second order tributary to Boundary Creek with a dendritic stream feeder pattern. Tributaries to Blue Joe Creek are orientated in an east and west aspect. Elevation in the watershed ranges from 4,115 feet above mean sea level to 6,677 feet above mean sea level.

The Blue Joe Creek watershed is predominantly underlain by metasedimentary rocks and minor portions of the Kaniksu Batholith. The granite and metasedimentary rocks are typically divided, with the highly weathered material occurring along the lower elevations and the weakly weathered material occupying the uplands and ridgelines.

The area is characterized by warm, dry summers and cold, wet winters. The majority of the precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. The majority of the watershed is vegetated by coniferous species.

1.2.4.5. Boulder Creek

Boulder Creek is an 40,533-acre watershed west of Bonners Ferry, Idaho, and flows into the Kootenai River less than a half mile west of the Idaho/Montana border. The Boulder Creek watershed is a relatively unentered watershed, with the majority of silviculture activity occurring to the east of East Fork Boulder Creek. Major tributaries to Boulder Creek include East Fork Boulder Creek, McGinty Creek, Gable Creek and Pinochle Creek. For the purposes of this assessment, Boulder Creek, along with major and minor tributaries, are all combined and referred to in this report as Boulder Creek. The Boulder Creek watershed is almost entirely located in Boundary County with a small portion of the southern edge protruding into Bonner County. Land within the watershed is publicly owned and managed by the United States Forest Service.

Boulder Creek is a third order tributary, with a dendritic stream feeder pattern to the Kootenai River. The drainage is orientated in a north by northeasterly direction with side tributaries entering from the east, west, north and south. Elevation in the watershed ranges from 1,828 feet above mean sea level where Boulder Creek enters into the Kootenai River to 6,705 feet above mean sea level.

The Boulder Creek watershed is predominantly underlain by highly and weakly weathered Belt Supergroup metasediments. The Belt Supergroup metasediments are typically divided, with the highly weathered material occurring along the lower elevations and the weakly weathered material occupying the uplands and ridgelines.

The area is characterized by warm, dry summers and cold, wet winters. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. The majority of the watershed is vegetated by coniferous species such as Douglas-fir, grand fir, western larch, lodgepole pine, western red cedar, subalpine fir, and white pine.

1.2.4.6. Caribou Creek

Caribou Creek is an 8,418-acre forested watershed in northern Idaho of which 8,369 acres are managed for timber production the remainder is managed for agriculture or occupied by homesites. For the purposes of this assessment, Caribou Creek, along with major and minor tributaries, are all combined and referred to in this report as Caribou Creek. Caribou Creek flows into Snow Creek approximately 1/8 mile upstream of Deep Creek. Land ownership is primarily public, including in the Panhandle National Forest, managed by the USFS, Bonners Ferry Ranger District, the Bureau of Land Management; and State of Idaho, managed by the Idaho Department of Lands, Kootenai Valley Area Office. There are smaller areas of private land. The watershed is located in Boundary County, Idaho.

Caribou Creek is a second order tributary, with a dendritic stream feeder pattern, to the Deep Creek. The drainage is oriented in an east by northeasterly direction with side tributaries entering mostly from the north and south. Elevation in the watershed ranges from 1,740 feet where Caribou Creek empties into Snow Creek to 7,260 feet in the headwaters on Roman Nose.

The Caribou Creek drainage is predominantly underlain by highly and weakly weathered granitics of the Kaniksu Batholith, and very minor inclusions of course textured alluvium and highly weathered Belt Supergroup metasediments. The granite rocks and metasediments are typically divided, with the highly weathered material occurring along the lower elevations and dominating the main stem floodplain and lower tributary floodplains. The weakly weathered material occupies the uplands and ridgelines.

The area is characterized by warm, dry summers and cold, wet winters, with an average annual precipitation ranging from 25 inches at the lower elevations to 50 inches at the higher elevations. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. The open lowlands near the mouth of the river are a mixed landscape of forested and non-forested areas, which are dominated by grasses and forbs. Forested riparian areas along floodplains typically support mixed broadleaf and needleleaf hydrophilic species. Strong south to west facing slopes at lower elevations support Douglas fir, lodgepole pine, and ponderosa pine vegetation types. With increasing elevation, forest stands become denser with a greater numbers of conifer species. The presence of Douglas-fir, grand fir, western larch, lodgepole pine, western red cedar, and western white pine increases with increasing elevation and effective precipitation. Higher elevations grade into subalpine vegetative types that include subalpine fir and spruce interspersed with brushy glades. At the very highest elevations, especially where glacial scouring and past wildfire impacts are strongest, vegetation becomes purely alpine, with no trees and abundant rock outcrop.

1.2.4.7. Streams Removed as TMDL Candidates

Three of the streams listed on the 1998 §303(d) list (Blue Joe Creek, Boulder Creek and Caribou Creek) have been removed as candidates for sediment TMDL development. Draft TMDLs were developed that demonstrated that current sediment generating conditions were better than those that assured full support of the beneficial uses in the area. Additionally, the listings were based on 1995 Beneficial Use Reconnaissance Project data which are contrary to more recent data collected, and Stressor Identification Analysis (EPA 2000) performed by DEQ supported their removal as TMDL candidates.

The in-stream water quality targets for the Blue Joe, Boulder and Caribou Creek’s sediment TMDLs are to achieve full support of the cold water designated use (Idaho Code 39.3611, .3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

Draft TMDLs were developed for these streams that included loading capacities in terms of mass per unit time. Pollution reduction goals (targets) were set based on conditions from neighboring watersheds that supported cold water aquatic life. All sources of sediment to Blue Joe, Boulder and Caribou Creek are nonpoint sources. The draft TMDL addresses the nonpoint sediment yield to the watershed.

The draft TMDLs apply sediment allocations in tons per year and calculate sediment reduction goals. According to the evidence outlined in chapter 5, the 50% above background target appears to be reasonable and very protective of the beneficial uses of the watersheds in the Lower Kootenai River Subbasin. In developing the draft TMDLs for these streams, DEQ discovered loads in Blue Joe, Boulder and Caribou Creeks are less than 50% above background levels. Estimated loads compared to load capacities are shown in Table 1 for Blue Joe Creek, Table 2 for Boulder Creek, and Table 3 for Caribou Creek.

Table 1. Blue Joe Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% above Background (tons/year)	Estimation Method
Sediment	Blue Joe Creek BURP ID 1994SCDA A033	6,002	211	180	270	GIS Estimate*

[1]Beneficial Use Reconnaissance Program
*Steps taken to derive GIS estimates can be found in Appendix F

Table 2. Boulder Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% above Background (tons/year)	Estimation Method
Sediment	Boulder Creek BURP ID 1994SCDA A033	40,533	1,234	1,216	1,824	GIS Estimate*

[1]Beneficial Use Reconnaissance Program
*Steps taken to derive GIS estimates can be found in Appendix F

Table 3. Caribou Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% above Background (tons/year)	Estimation Method
Sediment	Caribou Creek BURP ID 1994SCDA A033	8,376	251	251	376	GIS Estimate*

[1]Beneficial Use Reconnaissance Program
*Steps taken to derive GIS estimates can be found in Appendix F

1.2.4.8. Moyie River

Moyie River Lower Sidewalls is a 920-acre watershed in north Idaho. Moyie River Lower Sidewalls consists of a low gradient reach with broad depositional areas and steep canyon walls. Land in the area supports a multitude of uses including agriculture, an industrial site, rural and urban development, recreational sites and siviculture. For the purposes of this assessment, Moyie River Lower Sidewalls, along with major and minor tributaries, are all combined and referred to in this report as Moyie River Lower Sidewalls.

Moyie River Lower Sidewalls flows into Kootenai River approximately 1 mile below the Moyie Falls Dam at Moyie Springs, Idaho near U.S. Highway 2. Land ownership is primarily public and managed by USFS Bonners Ferry Ranger District; Kaniksu National Forest, Bureau of Land Management, private timber corporations, private railroad interests and small private land owners. The watershed is wholly located in Boundary County, Idaho (Figure 5).

Moyie River Lower Sidewalls is a fourth order tributary to the Kootenai River, with a dendritic stream feeder pattern. The drainage is oriented in a southerly direction with side tributaries entering mostly from the northwest and east. Elevation in the watershed ranges from 1,790 feet where Moyie River Lower Sidewalls empties into Kootenai River to 4,445 feet in the headwaters.

The Moyie River Lower Sidewalls drainage is predominantly underlain by glacial outwash drift/till, Columbia River basalt flow material, and highly and weakly weathered Belt Supergroup metasediments. The Belt Supergroup metasediments are typically divided, with the highly weathered material occurring along the lower elevations and lower tributary floodplains where they occur. The weakly weathered material occupies the uplands and ridgelines.

The area is characterized by warm, dry summers and cold, wet winters, with an average annual precipitation ranging from 20 inches at the lower elevations to 30 inches at the higher elevations. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. Much of the low lying floodplain is dominated by grasses, forbs, and mixed conifer/broadleaf vegetation types. Forested riparian areas along floodplains typically support mixed grasses, forbs, alder/willow, western red cedar/western hemlock vegetation types, and other hydrophilic species. Strong south to west facing slopes at lower elevations support stands dominated by ponderosa pine vegetation types. Forest stands generally become denser with a greater number of coniferous species as elevation and effective precipitation increase as noted by the presence of Douglas fir, grand fir, western hemlock, western red cedar, western white pine, western larch, western spruce, and sub-alpine fir.

Moyie River, from the Moyie River Dam to its confluence with the Kootenai River, is listed for TMDL development on the 1998 §303(d) list, with excess sediment as its pollutant. DEQ does not have Beneficial Use Reconnaissance Program monitoring data on this section of Moyie River, and believes listing decisions were based anecdotal understandings and information. DEQ has evidence suggesting that the listing resulted from a single fine sediment deposition event, and that the stream has recovered since that event (see Figure 12, showing the river in 1984). Mechanisms are in place to prevent similar events from occurring. Therefore, DEQ and the Kootenai and Moyie River WAG maintains that TMDL calculations are inappropriate and that the section of Moyie River below the dam be removed from the §303(d) list. Future monitoring should be continued in the Moyie River watershed for future evaluation of beneficial use status.

In 1984 the Moyie River received a large quantity of sediment from a single event. The event was a sediment release resulting from the operation of the Moyie hydroelectric project. The Moyie hydroelectric project consists of a small run of the river reservoir and a low head dam that is operated by the City of Bonners Ferry. According to DEQ file notes: On Saturday, August 18, 1984, the City of Bonners Ferry used the drain valve of the Moyie hydroelectric project in order to gain above water access for cleaning and repair of the trash racks. The dam was drawn down 51 feet overnight. As a result of the draining, a tremendous amount of fine sediment that had been held upstream below surface banks was deposited downstream and buried the Moyie Springs and Three Mile water intakes. The fine sediment made it impossible for these two systems to pump water from the river (DEQ 1984). According to a newspaper article (Bonners Ferry Herald 1984), the mudslide was unexpected.

Figure 12. Moyie River, 1984.

According to Bonners Ferry staff, quantities of fine sediment behind the dam were not apparent. The City of Bonners Ferry has not seen the accretion of fine sediment behind that dam like that seen in 1984 at any other time. It is believed that the fine sediment existing in 1984 resulted from ash deposition related to the May 1980 Mount St. Helens eruption (Stephen Boorman 2005). DEQ staff visited the Moyie River on August 29, 2005, and observed “little to no fine sediment in the section below the dam” (see Figure 13, showing the same location on the river in 2005).

Mechanisms are in place to prevent similar events from occurring at the Moyie hydroelectric project. The United States Federal Energy Regulatory Commission (FERC) has issued an order approving City of Bonners Ferry's Sediment Removal Plan. This plan outlines consultation with Idaho DEQ, USFWS, and the Kootenai Tribe. When sediments upstream from the dam accumulate, the City of Bonners Ferry must remove and dispose of these sediments. Disposal must be conducted during low flow periods, using a portable cutter-head suction dredge, and allowed to settle in un-lined basins. Drain exercises will be conducted when flows are in excess of 2000 cfs (FERC 2005).

Figure 13. Moyie River, 2005.

1.3. Cultural Characteristics

The Lower Kootenai and Moyie River Subbasins contain an abundance of natural resources, transportation, and economic possibilities. From times when the Kootenai Tribe of Idaho inhabited the land, to the discovery of gold in 1863 (Bonners Ferry Chamber of Commerce 2003), the Lower Kootenai and Moyie River Subbasins have grown and changed, providing a strong historical and cultural background.

1.3.1. Land Use

The Lower Kootenai and Moyie River Subbasins consist primarily of forested land. Examples of forest land use within the basin include timber harvest, recreation, wilderness and mineral extraction to name a few. Greater than 90% of Boundary County is forested, with the Selkirk, Purcell, and Cabinet Mountain Ranges crossing the county. Much of the Lower Kootenai and Moyie River Subbasins are located within the Kaniksu National Forest, while the Idaho portion of the Upper Kootenai River Subbasin is located within the Kootenai National Forest.

Along with forest land in the Lower Kootenai and Moyie River Subbasins, dry land agriculture and rangeland also exist, but to a much smaller extent, as shown in Figure 14 and Figure 15. Fertile farming grounds are restricted to roughly 50,000 acres along the old floodplain of the Kootenai River valley and bench areas above the floodplain. Along the floodplain, crops such as spring and winter wheat and canola, spring barley, timothy, and white clover are grown. In the bench areas, spring and winter wheat, spring barley, alfalfa hay and seed, and grass hay are grown (Bonners Ferry Chamber of Commerce 2003).

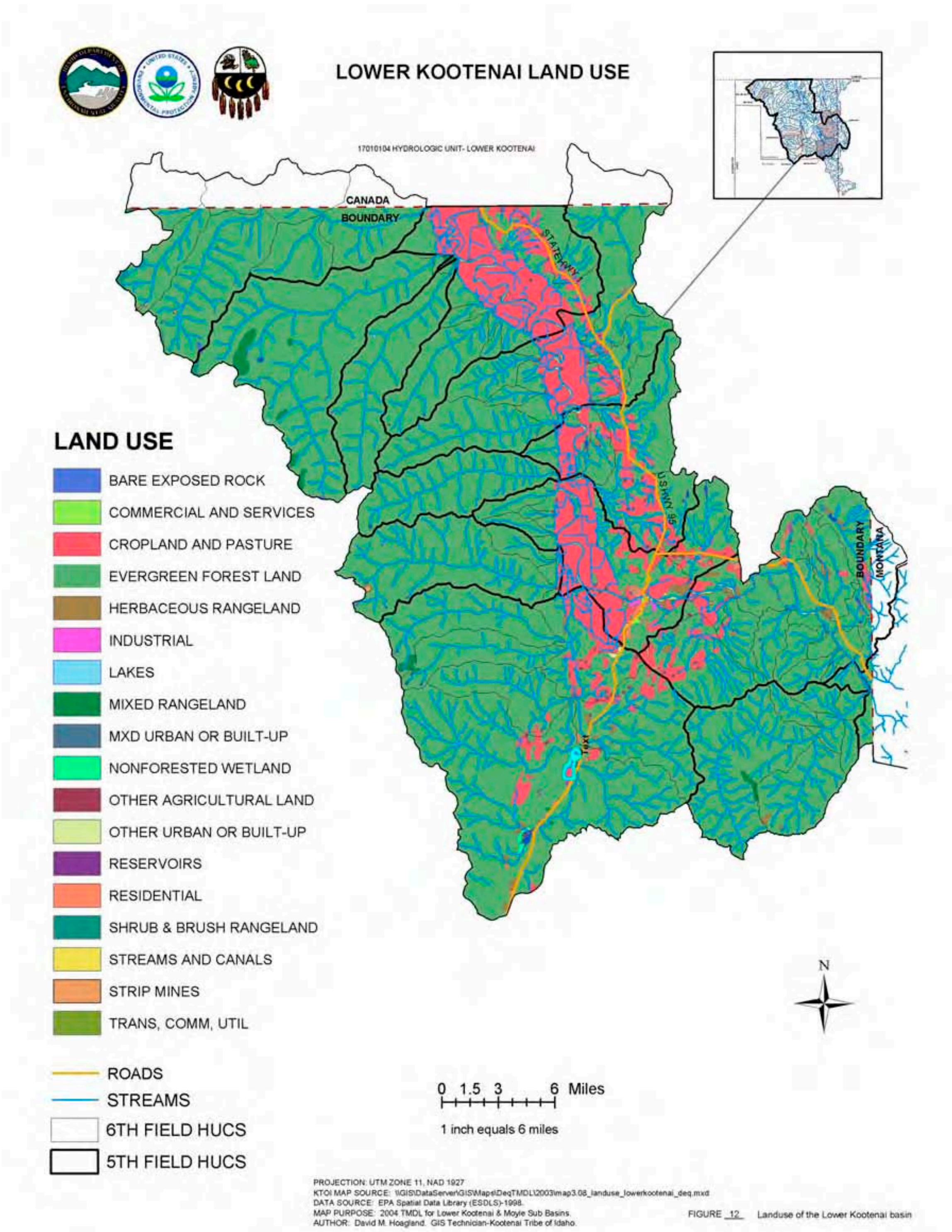

Figure 14. Land use types in the Lower Kootenai River Subbasin.

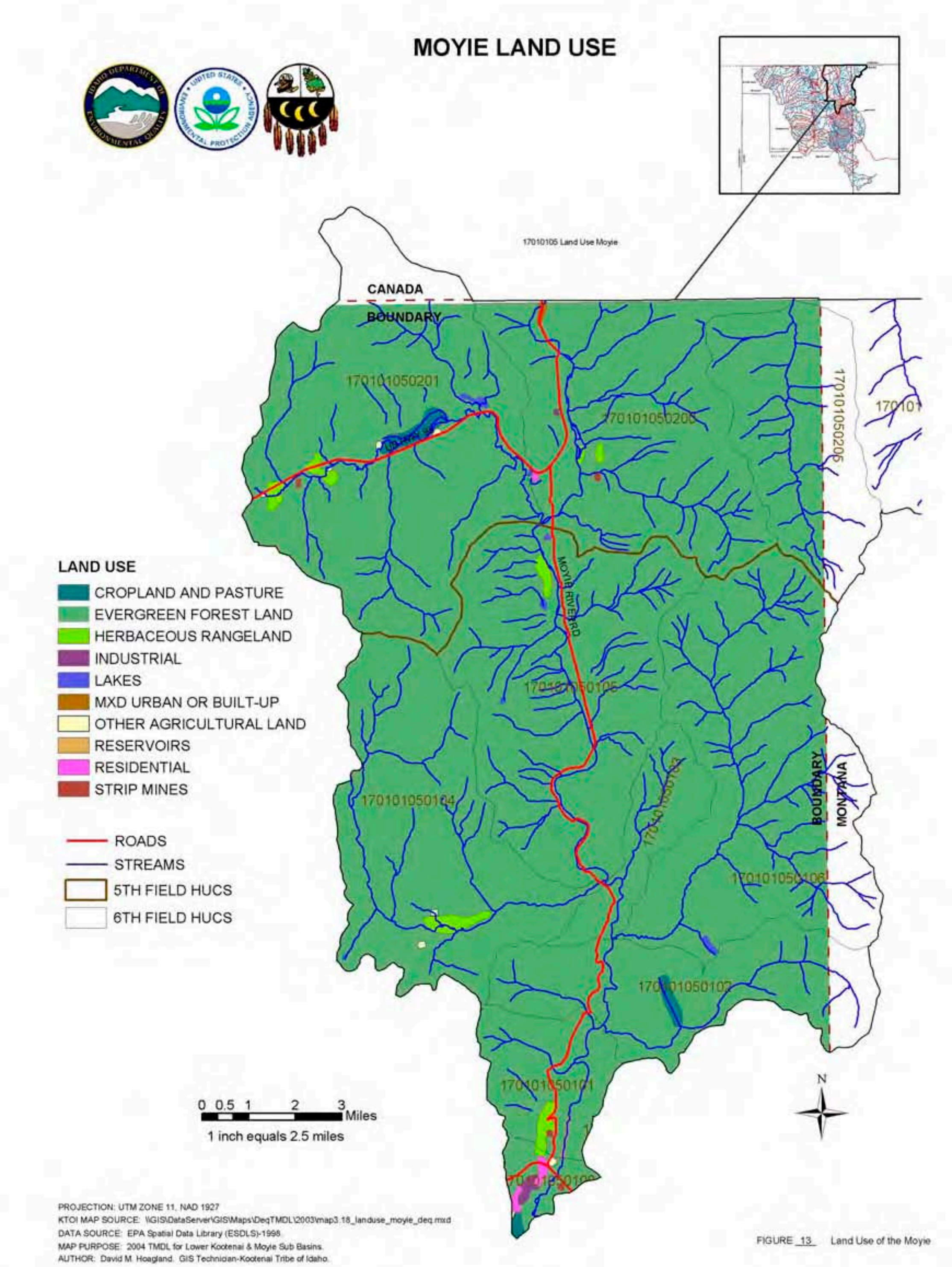

Figure 15. Land Use Types in the Moyie River Subbasin.

A number of road systems in the Lower Kootenai and Moyie Subbasins exist. Currently, the Boundary County Road and Bridge Department maintains 340 miles of public roadway in Boundary County, while the Idaho Department of Transportation maintains 78 miles along U.S. 95, Highway 1, and U.S. 2 (Boundary County Chamber of Commerce 2003).

1.3.2. Land Ownership, Cultural Features, and Population

The United States Forest Service and private entities own the majority of the land in the Lower Kootenai and Moyie Subbasins. Figure 16 shows land ownership in the Lower Kootenai Subbasin and Figure 17 shows land ownership in the Moyie Subbasin. The Lower Kootenai Subbasin consists of 530,236 acres in Idaho and the Moyie Subbasin consists of 113,365 acres in Idaho. Privately owned land is in the form of dry land agriculture along the fertile Kootenai River Valley (215,658 acres); however, approximately 100,000 acres are forested. The Idaho Department of Lands (24,385 acres), the Bureau of Land Management (4,976 acres), the United States Fish and Wildlife Department (2,814 acres), and the Idaho Department of Fish and Game (1,622 acres) manage the remaining land.

As shown in Figure 17, the Moyie Hydroelectric Dam is the only major dam within the three subbasins. It is located just upstream from Moyie Falls in the Moyie Subbasin and is owned by the City of Bonners Ferry. First licensed in 1949, the dam stands 92 feet high, and produces 3,950 kilowatts of electricity. The license is issued by the Federal Energy Regulatory Commission (FERC).

The City of Bonners Ferry holds the only two National Pollution Discharge Elimination Systems (NPDES) permits in Boundary County. The permits, issued by EPA on November 5, 1998, are for wastewater and water treatment systems. These are the only permitted point sources of pollution in the Upper and Lower Kootenai and Moyie Subbasins.

The majority of the Lower Kootenai Subbasin and the Idaho portions of the Moyie Subbasin lie entirely in Boundary County, which has a population of 9,189. From 1990 to 1997, the population of Boundary County increased 18.6%, and the county added 223 people a year with three-fourths of those from net migration, or the difference between people moving in and out of the county (Bonners Ferry Chamber of Commerce 2003). The most populous city in Boundary County is the County Seat of Bonners Ferry, with a population of 2,193. Other cities in Boundary County include Porthill, Copeland, and Naples in the Lower Kootenai Subbasin, and East Port and Moyie Springs in the Moyie Subbasin.

Most of the Upper Kootenai Subbasin and a very small portion of the Lower Kootenai Subbasin lie in Bonner County, which has a population of 31,890. The Bonner County population has been growing steadily, averaging 7-8% growth per year in the past five years (Bonner County Idaho 2003). The County Seat is Sandpoint, which is the most populous city in the county (5,203). The only towns in Bonner County that lies within the Lower Kootenai Subbasin are the towns of Elmira and Bonners Ferry. No major towns in the Upper Kootenai Subbasin exist in Idaho. The population of both Bonner and Boundary Counties continue to grow as a result of the recreational opportunities, beautiful scenery, and quality of life the counties have to offer (Bonner County Idaho 2003 and Bonners Ferry Chamber of Commerce 2003). Counties are shown on the map in Figure 18.

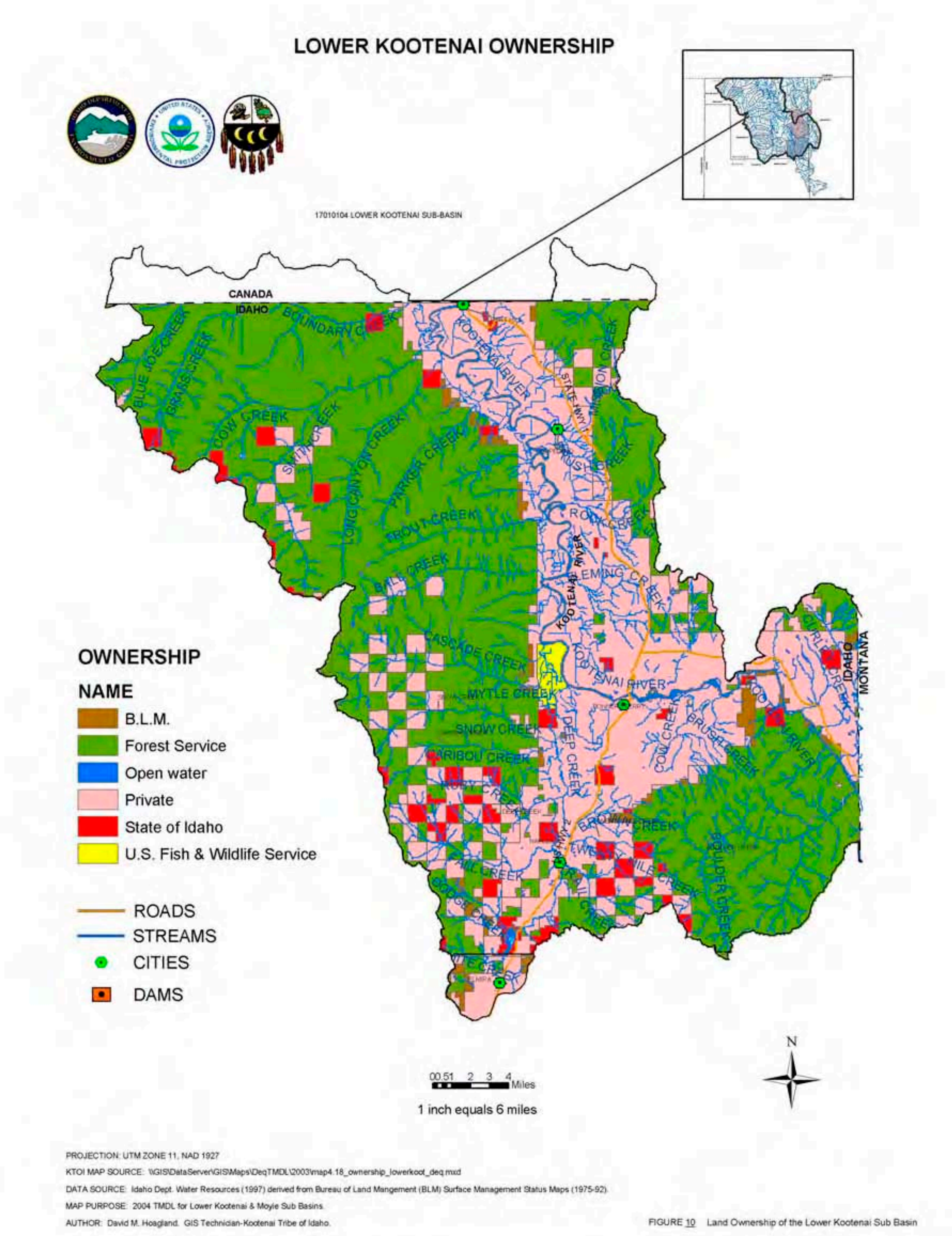

Figure 16. Land ownership in the Lower Kootenai River Subbasin.

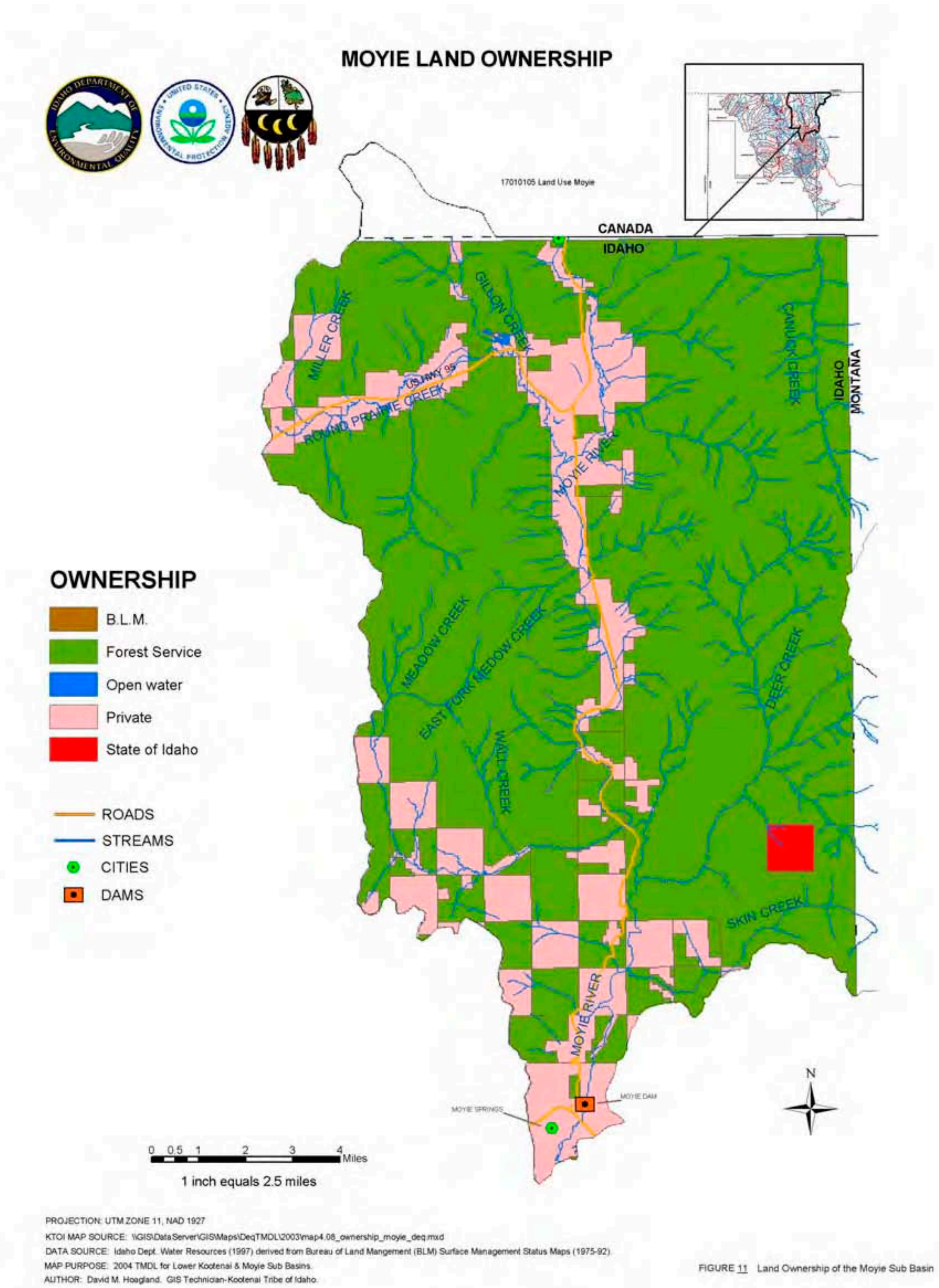

Figure 17. Land ownership in the Moyie River Subbasin.

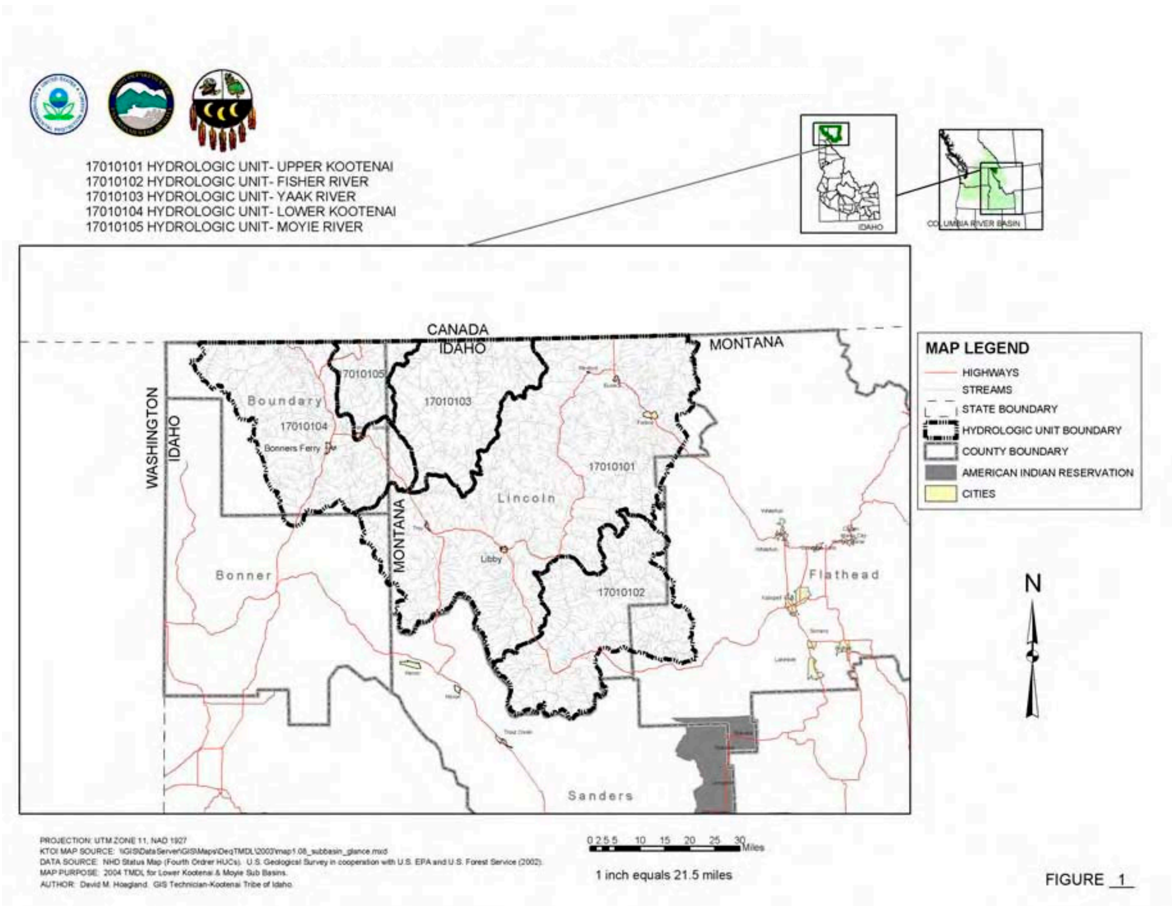

Figure 18. Kootenai River Subbasin hydrologic units.

1.3.3. History and Economics

The original inhabitants of Boundary County were the members of what is now known as the Kootenai Tribe of Idaho (Bonners Ferry Chamber of Commerce 2003). The Tribe is one of seven bands of the Kootenai Nation, which exists throughout Northern Idaho, British Columbia, and Northwestern Montana. In addition to the Kootenai Tribe of Idaho, the Nation is made up of the Lower Kootenai Band near Creston, BC; the St. Mary's Band near Cranbrook, BC; the Columbia Lake Band near Windermere, BC; the Shuswap Band near Invermere, BC; the Tobacco Plains Band near Fernie, BC; and the Confederated Salish and Kootenai Tribe (Shottanana 2003). The Kootenai Tribe has occupied the area since ancient times, and has used the natural resources of the land for hunting, fishing, and gathering items such as berries, moss, and other plants used for medicinal or ceremonial gatherings (Shottanana 2003). In 1991, the Tribe built the Kootenai Tribal Sturgeon Hatchery to help increase the population of the endangered sturgeon species, which plays a large role in their tribal heritage (Bonners Ferry Chamber of Commerce 2003). Currently, about 75 members of the Kootenai Tribe of Idaho live in a modern village at an 18-acre mission three miles northwest of Bonners Ferry. The Tribe made a significant contribution to the economy of the area in 1986 by building the Kootenai River Inn at Bonners Ferry. In 1993, the luxury hotel also became a center for bingo and gaming machines, increasing the number of jobs, as well as the number of visitors to the area (Bonners Ferry Chamber of Commerce 2003).

Since the late 1800s, timber production has been the foundation of economic stability in the Lower Kootenai and Moyie Subbasins. In 1913, the Bonners Ferry Lumber Company grew to be one of the world's largest lumber mills producing 50 million board feet (Tom Hudson Company 2001). Employment in mills and logging reached an all time high of 704 in 1997 (Bonners Ferry Chamber of Commerce 2003). The timber industry employs not only the loggers and mill workers, but also members of railroad crews working with the industry. Since the 1920s and 30s, agriculture has been a significant industry in the subbasins, as well, with a variety of crops, fruits, and vegetables being grown in the fertile Kootenai River Valley.

Although it is no longer prominent, mining was a major industry in the 1800s. When gold was discovered in British Columbia in 1863, a rush of settlers from the west came north over the Wildhorse Trail. A ferry was established by Edwin Bonner in 1864 where the trail crossed the Kootenai River, and by 1883, a steamboat called "Midge" was carrying passengers and freight between the town soon to be known as Bonners Ferry and British Columbia. Railroads were soon developed as well, with the Great Northern Railroad (now Burlington Northern Sante Fe Railway) being built in 1892, and the Spokane International (now Union Pacific) and Kootenai Valley lines (now ceased) soon following (Bonners Ferry Chamber of Commerce 2003). The Spokane International and Burlington Northern Railroad systems remain active in the area today.

One of the most prominent mines of the time was the Idaho Continental Mine, which was discovered in 1890 on the crest of the Selkirk Range in northwestern Boundary County near Porthill, Idaho. The mine produced large quantities of lead and silver, as well as smaller amounts of gold, zinc, and copper. Ore was shipped out of the mine until 1980, the same year it was leased by New Idaho Continental Mines. In 1984, a cooperative program between the United States Forest Service, the Idaho Department of Health and Welfare, the Soil Conservation Service (now the Natural Resources Conservation Service), the University of Idaho, the Idaho National Guard, and New Idaho Continental Mines, Inc., was formed to reclaim the Idaho Continental Mine tailings piles (Mitchell 2000). Through this program, it was found that the major sources for metals in Blue Joe Creek, which is currently on the §303(d) list for failing to meet water quality criteria, are seepage and leaching of tailings piles of the Idaho Continental Mine's tunnel No. 5 (Mitchell 2000). Currently, no active mines are present in the Lower Kootenai and Moyie Subbasins; however, remnants of past mines are still affecting water quality today. Environmental cleanup activities have been completed and Blue Joe Creek is recovering. More details are in the Key Findings portion of the Executive Summary, and in section 2.4.5.

Wages in Boundary County, as in many rural counties in Idaho, tend to be lower than in most of the United States. That partly reflects the county’s lower cost of living, but also results from long-term high unemployment, which tends to push wages down. Low wages and relatively high unemployment keep income levels below the national and state income levels. In the 1990s the county enjoyed strong job growth, however, the timber industry’s decline and the U.S. economic slowdown eroded the county’s employment base. In 2004, the economy showed renewed strength.

The Kootenai Valley was full of resources and opportunity, making it known as the "Nile of the North" (Tom Hudson Company 2001). The substantial migration of ore-seeking settlers to the area caused a great deal of hardship on the Kootenai Tribe, as the natural resources the Tribe valued were the same as the resources drawing the settlers to the country. However, the Kootenai River played an essential role for both groups by providing sources of food, transportation, and recreation, and by promoting economic stability in the subbasins as it does today.

Today, local governments and civic groups work together on water quality issues in the Upper and Lower Kootenai and Moyie River Subbasins.

2. Subbasin Assessment – Water Quality Concerns and Status

The Kootenai River and most of its tributaries in the basin are not listed as water quality limited under Subsection 303(d) of the Clean Water Act. Seven stream segments in the Lower Kootenai and Moyie River Subbasins are listed under Subsection 303(d) of the CWA 1998 Idaho list. Streams that have been assessed and found to be supporting beneficial uses, and therefore not §303(d) listed, are shown in Table 4.

Table 4. Lower Kootenai River and Moyie River Subbasin beneficial uses of streams assessed but non-listed on the 1998 §303(d) list.

Water Body	Assessment Unit	Uses[a]	Type of Use
Callahan Creek	ID17010104PN0	CWAL, PCR	Presumed
Long Canyon Creek	ID17010104PN008_02	CWAL, SS, PCR	Designated
Mission Creek	ID17010104PN038_02 ID17010104PN038_03	CWAL, SS	Designated
Myrtle Creek	ID17010104PN013_02 ID17010104PN013_03	CWAL, SS, PCR	Designated
Parker Creek	ID17010104PN009_02 ID17010104PN009_03	CWAL, SS, PCR	Designated
Ruby Creek	ID17010104PN020_02 ID17010104PN020_03	CWAL, SS, PCR	Designated
Smith Creek	ID17010104PN0	CWAL, SS, PCR	Designated
Placer Creek	ID17010104PN0	CWAL, PCR	Presumed

[a] CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply

2.1. Water Quality Limited Assessment Units Occurring in the Subbasin

Subsection 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

The Lower Kootenai and Moyie River Subbasins have a total of six water quality limited stream segments on the 1998 §303(d) list for sediment, one for metals, one for pH, and two for temperature. These are shown in Table 5.

Table 5. 1998 §303(d) Segments in the Lower Kootenai and Moyie River Subbasins.

Water Body Name	Assessment Unit ID Number	1998 §303(d) Boundaries	Pollutants	Listing Basis
Boulder Creek	ID17010104PN032_03	Headwaters to Kootenai River	Sediment	Unknown
Deep Creek	ID17010104PN015_04	McAurthur Lake to Kootenai River	Sediment, Temp	EPA addition
Blue Joe Creek	ID17010104PN004_02	Headwaters to Canadian border	Sediment, Metals., pH	Unknown

Caribou Creek	ID17010104PN017_02	Headwaters to Snow Creek	Sediment	Unknown
Cow Creek	ID17010104PN006_03	Headwaters to Smith Creek	Sediment	Unknown
Boundary Creek	ID17010104PN002_03	Canadian/Idaho border to Kootenai River	Temp	EPA addition
Moyie River	ID17010105PN001_05	Moyie Falls dam to Kootenai River	Sediment	Unknown

The 2002 Integrated Report (formally known as the §303(d) list) includes numerous additional waterbodies listed for temperature criteria exceedances. These segments are shown in Figure 19 and listed in Table 6, including their segment ID numbers, designated boundaries, and listed pollutants.

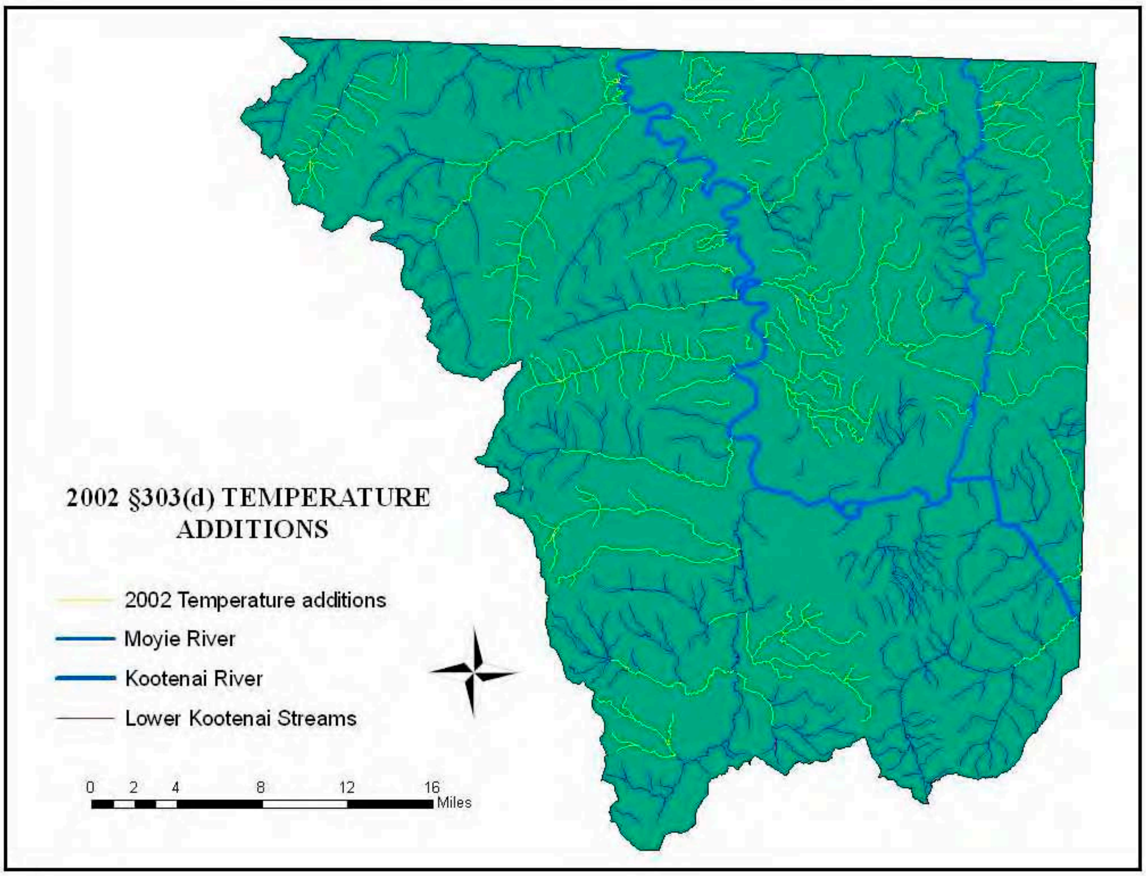

Figure 19. Streams added to the 2002 §303(d) list for temperature.

Table 6. 2002 additions to the 1998 §303(d) list.

Stream Name	Assessment Unit ID number	2002 §303(d) Boundaries	Listed Pollutants
Ball Creek	ID17010104PN011_02	Source to mouth	Temperature
Boulder Creek	ID17010104PN032_03	East Fork Boulder Creek to mouth	Temperature, siltation
Brown Creek	ID17010104PN027_02	Source to mouth	Temperature

Stream Name	Assessment Unit ID number	2002 §303(d) Boundaries	Listed Pollutants
Caribou Creek	ID17010104PN017_02	Source to mouth	Temperature, suspended solids, siltation
Caribou Creek	ID17010104PN016_03	Source to mouth	Temperature
Cow Creek	ID17010104PN006_03	Source to mouth	Temperature, suspended solids, siltation
Curley Creek	ID17010104PN035_03	Source to mouth	Temperature
Dodge Creek	ID17010104PN024_02	Source to mouth	Temperature
Dodge Creek	ID17010104PN024_04	Source to mouth	Temperature
Fall Creek	ID17010104PN021_03	Source to mouth	Temperature, causes unknown
Fisher Creek	ID17010104PN001_02	Shorty's Island to Idaho/Canadian border	Temperature
Fleming Creek	ID17010104PN036_02	Source to mouth	Temperature
Fleming Creek	ID17010104PN036_03	Source to mouth	Temperature
Grass Creek	ID17010104PN003_02	Source to Idaho/Canadian border	Temperature
Long Canyon Creek	ID17010104PN008_02	Source to mouth	Temperature
Mission Creek	ID17010104PN038_03	Brush Creek to mouth	Temperature
Mission Creek	ID17010104PN040_03	Idaho/Canadian border to Brush Creek	Temperature
Myrtle Creek	ID17010104PN013_03	Source to mouth	Temperature
Parker Creek	ID17010104PN009_03	Source to mouth	Temperature
Rock Creek	ID17010104PN037_02	Source to mouth	Temperature
Rock Creek	ID17010104PN037_03	Source to mouth	Temperature
Ruby Creek	ID17010104PN020_03	Source to mouth	Temperature
Smith Creek	ID17010104PN005_04	Cow Creek to mouth	Temperature
Smith Creek	ID17010104PN007_03	Source to Cow Creek	Temperature
Snow Creek	ID17010104PN016_02	Source to mouth	Temperature
Snow Creek	ID17010104PN016_03	Source to mouth	Temperature
Trail Creek	ID17010104PN026_03	Source to mouth	Temperature
Trout Creek	ID17010104PN010_03	Source to mouth	Temperature
Twentymile Creek	ID17010104PN027_03	Source to mouth	Temperature
Twentymile Creek	ID17010104PN028_02	Source to mouth	Temperature
Blue Joe Creek	ID17010105PN004_02	Source to Idaho/Canadian border	Temperature
Brass Creek	ID17010105PN006_02	Idaho/Canadian border to Round Prairie Creek	Temperature
Canuck Creek	ID17010105PN007_02	Idaho/Montana border to Idaho/Canadian border	Temperature
Copper Creek	ID17010105PN006_02	Idaho/Canadian border to Round Prairie Creek	Temperature
Deer Creek	ID17010105PN003_02	Source to mouth	Temperature
Deer Creek	ID17010105PN004_03	Source to mouth	Temperature
Faro Creek	ID17010105PN004_02	Source to mouth	Temperature
Gillon Creek	ID17010105PN009_02	Idaho/Canadian border to mouth	Temperature
Keno Creek	ID17010105PN004_02	Source to mouth	Temperature
Meadow Creek	ID17010105PN012_03	Source to mouth	Temperature
Miller Creek	ID17010105PN011_02	Source to mouth	Temperature
Placer Creek	ID17010105PN002_02	Meadow Creek to Moyie Falls Dam	Temperature
Round Prairie Creek	ID17010105PN010_03	Source to Gillon Creek	Temperature

Stream Name	Assessment Unit ID number	2002 §303(d) Boundaries	Listed Pollutants
Skin Creek	ID17010105PN003_02	Idaho/Montana border to mouth	Temperature
Skin Creek	ID17010105PN003_02	Idaho/Montana border to mouth	Temperature
Spruce Creek	ID17010105PN006_02	Idaho/Canadian border to Round Prairie Creek	Temperature, causes unknown
Wall Creek	ID17010105PN012_02	Source to mouth	Temperature
West Fork Deer Creek	ID17010105PN004_02	Source to mouth	Temperature

2.1.1. About Assessment Units

Assessment units (AUs) now define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the *Water Body Assessment Guidance*, second edition (WBAG II) (Grafe et al. 2002).

Assessment units are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—although ownership and land use can change significantly over time, the AU remains the same.

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's §305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, there is now a direct geo-referenced tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of §303(d) listed streams. Due to the nature of the court-ordered 1994 §303(d) listings, and the subsequent 1998 §303(d) list, all segments were added with boundaries from "headwaters to mouth." In order to deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ began developing TMDLs at the watershed scale (HUC), so that all the waters in the drainage are being or have been considered for TMDL purposes since 1994.

The boundaries from the 1998 §303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to the way DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 §303(d) listings in Section 5 of the Integrated Report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the §303(d) list. This was necessary to maintain the integrity of the 1998 §303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of water quality listing and de-listing.

When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (de-listed) from the §303(d) list (Section 5 of the Integrated Report).

2.1.2. Listed Waters

Table 5 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the subbasin. Not all of these water bodies will require a TMDL, which has been discussed in Section 1.2.4 Stream Characteristics. However, a thorough investigation, using the available data, was performed before this conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections.

2.2. Applicable Water Quality Standards

The water quality standards designate beneficial uses and set water quality goals for the waters of the state. The designated uses for the Idaho portions of the Lower Kootenai and Moyie River Subbasins appear below.

2.2.1. Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The WBAG II (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

2.2.1.1. Existing Uses

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

2.2.1.2. Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160 in addition to citations for existing uses).

2.2.1.3. Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If, in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, a use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Beneficial uses for §303(d) listed watersheds in the Lower Kootenai and Moyie River Subbasins are listed in Table 7. A complete list of beneficial uses in the subbasins can be found in the Idaho water quality standards.

Table 7. Lower Kootenai and Moyie River Subbasins beneficial uses of §303(d) listed streams.

Water Body	Assessment Unit	Uses[a]	Type of Use
Boulder Creek- Headwaters to Kootenai River	ID17010104PN032_03 ID17010104PN033_02 ID17010104PN033_03	CWAL, SS, PCR	Designated
Deep Creek- McArthur Lake to Kootenai River	ID17010104PN025_02 ID17010104PN025_03 ID17010104PN019_04 ID17010104PN018_04 ID17010104PN015_04	CWAL, SS, PCR, DWS, SRW	Designated
Blue Joe Creek- Headwaters to Canadian border	ID17010104PN004_02	CWAL, SS, PCR	Designated
Caribou Creek- Headwaters to Snow Creek	ID17010104PN017_02	CWAL, SS, PCR	Designated
Cow Creek- Headwaters to Smith Creek	ID17010104PN006_02 ID17010104PN006_03	CWAL, SS, PCR	Designated
Boundary Creek- Idaho/Canadian border to Idaho/Canadian border	ID17010104PN002_02 ID17010104PN002_03	CWAL, SS, PCR	Designated
Moyie River- Moyie Falls dam to Kootenai River	ID17010105PN001_05	CWAL, SS, PCR, DWS, SRW	Designated

[a] CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – special resource water

2.2.2. Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250) (Table 8).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): "Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350."

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."

Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: "Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities."

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the WBAG II (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Table 8 includes the most common numeric criteria used in TMDLs. Figure 20 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 8. Selected numeric criteria supportive of designated and existing beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, pH, and Dissolved Oxygen (DO)	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Temperature[d]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October
			Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days.	
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature				7 day moving average of 10 °C or less maximum daily temperature for June - September

[a] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

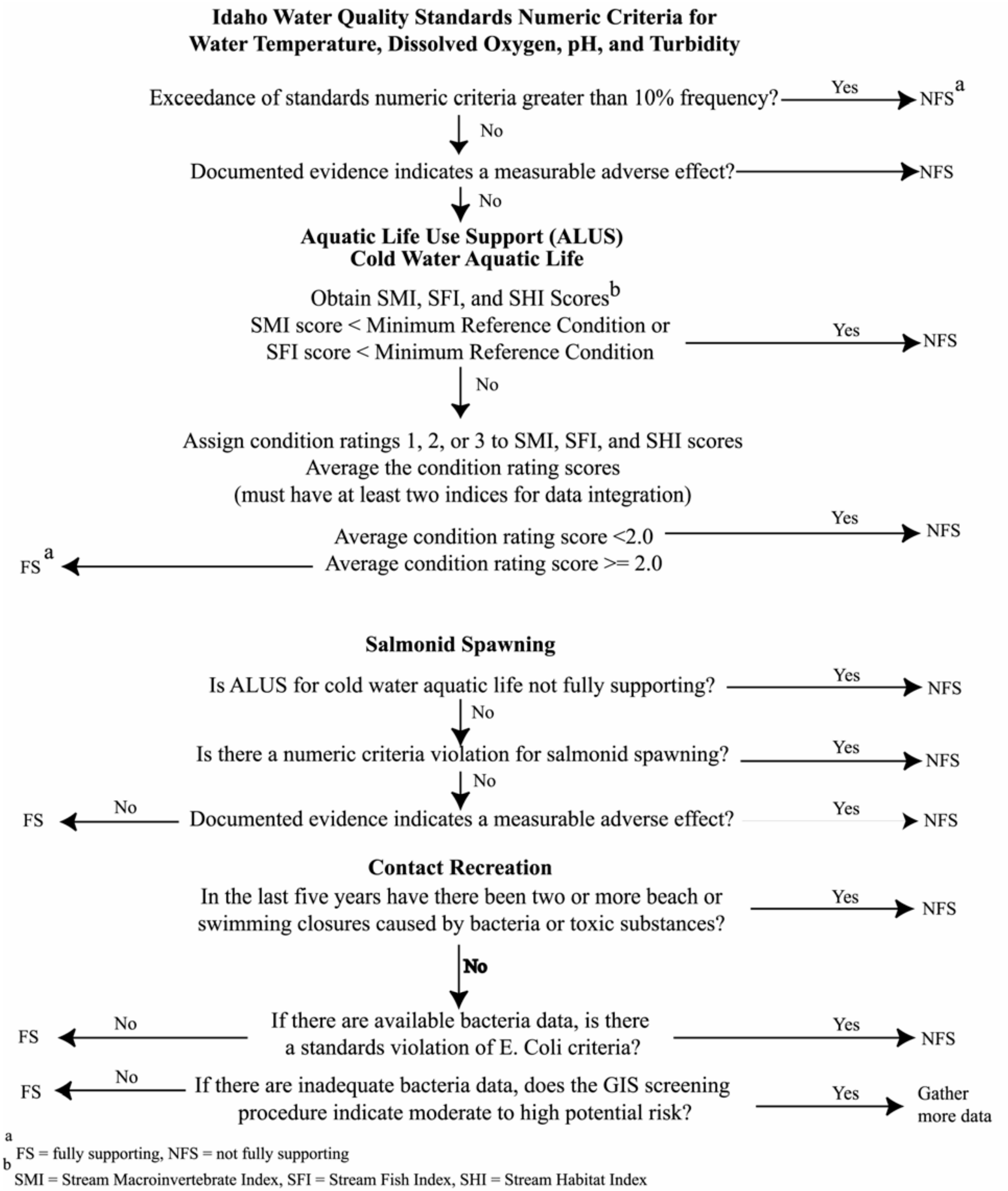

Figure 20. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: Water Body Assessment Guidance, Second Edition (Grafe et al. 2002).

2.3. Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans. That is, streams naturally have sediment, nutrients, and the like, but when anthropogenic sources cause these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream.

2.3.1. Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or cold water aquatic community is present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar kinds of effects may occur to aquatic invertebrates, amphibians and mollusks, although less is known about them.

2.3.2. Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen (the remainder) is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

Dissolved oxygen levels of 6 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6 mg/L, organisms are stressed, and if levels fall below 3 mg/L for a prolonged period, these organisms may die; oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. Dissolved oxygen levels below 1 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO.

Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water). In addition, oxygen is necessary to help decompose organic matter in the water and bottom sediments. Dissolved oxygen reflects the health or the balance of the aquatic ecosystem.

Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water from photosynthesis and from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering the water is called aeration.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. An oxygen sag will typically occur once photosynthesis stops at night and respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with the advent of daylight.

Temperature, flow, nutrient loading, and channel alteration all impact the amount of DO in the water. Colder waters hold more DO than warmer waters. As flows decrease, the amount of aeration typically decreases and the in-stream temperature increases, resulting in decreased DO. Channels that have been altered to increase the effectiveness of conveying water often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before the alteration. Nutrient enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower instream DO levels.

2.3.3. Sediment

Both suspended (floating in the water column) and bedload (moves along the stream bottom) sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases eventually lead to death.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel DO through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45-μm (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller TSS, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

2.3.4. Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus to rooted macrophytes in the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The USDA (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, when conditions become anoxic, sediments release phosphorous into the water column. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is, for the most part, a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This results in a reduction of nitrogen oxides (NO_x) being lost to the atmosphere.

Sediments can play an integral role in reducing the frequency and duration of phytoplankton blooms in standing waters and large rivers. In many cases there is an immediate response in phytoplankton biomass when external sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

2.3.5. Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae impact beneficial uses, the algae are considered a nuisance aquatic growth. The excess growth of phytoplankton, periphyton, and/or macrophytes can adversely affect both aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support growth. In addition to nutrient availability, flow rates, velocities, water temperatures, and penetration of sunlight in the water column all affect algae (and macrophyte) growth. Low velocity conditions allow algal concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algal growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support normal algal growth, excessive blooms may develop.

Commonly, algae blooms appear as extensive layers or algal mats on the surface of the water. When present at excessive concentrations in the water column, blue-green algae often produce toxins that can result in skin irritation to swimmers and illness or even death in organisms ingesting the water. The toxic effect of blue-green algae is worse when an abundance of organisms die and accumulate in a central area.

Algal blooms also often create objectionable odors and coloration in water used for domestic drinking water and can produce intense coloration of both the water and shorelines as cells accumulate along the banks. In extreme cases, algal blooms can also result in impairment of agricultural water supplies due to toxicity. Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The extent of the effect is dependent on both the type(s) of algae present and the size, extent, and timing of the bloom.

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the bottom. Low DO in these areas can lead to decreased fish habitat as fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Additionally, low DO levels caused by decomposing organic matter can lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations on excess algal growth within the water column, combined with the direct effect of the algal life cycle on DO and pH within aquatic systems. Therefore, the reduction of TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface-water systems dominated by blue-green algae, which can acquire nitrogen directly from the atmosphere and the water column. Phosphorus management within these systems can potentially result in improvement in nutrients (phosphorus), nuisance algae, DO, and pH.

2.4. Summary and Analysis of Existing Water Quality Data

Water quality samples have been collected by the USGS on the Kootenai River near Porthill, Idaho, from 1949 through 2001. Water quality sampling was conducted intermittently and consists of temperature, pH, specific conductance, dissolved oxygen, and nutrient data. Idaho DEQ Beneficial Use Reconnaissance Program (BURP) has collected data on a majority of perennial streams within the Idaho portions of the Lower Kootenai and Moyie River Subbains. Data sets collected by BURP surveys include habitat, macroinvertebrates and fisheries information. An extensive temperature study was conducted by DEQ on headwater streams of the basin from 1998-2002. A list of temperature data logger locations and duration and dates of deployment is provided in Appendix C. Numerous studies have been conducted exploring the interaction of hydroelectric power stations and fisheries on the

Kootenai River. Data from these reports were used in this section and other sections through out the TMDL. The above mentioned data are data sets which were used in this section, however, other data may exist.

2.4.1. Flow Characteristics

The USGS has operated 29 gauging stations in the basin from 1925 to 2003. Their locations are shown in Table 9.

The Kootenai River (spelled Kootenay in Canada) originates in southeastern British Columbia. From the headwaters, it flows south into Lake Koocanusa, which straddles the border between British Columbia and Montana. Libby Dam, operated by the U.S. Army Corp of Engineers, impounds the river to form the Lake Koocanusa reservoir. Downstream of the dam, near Libby, Montana, the river turns and flows westward toward Idaho. Near Bonners Ferry, Idaho, the river turns north, and flows again into British Columbia where it enters Kootenay Lake. From the outlet on the west arm of the lake near Nelson, BC, the river flows westward, through several hydropower impoundments, to its confluence with the upper Columbia River near Castlegar, BC.

Table 9. USGS gauging station locations in the Kootenai and Moyie River drainages in Idaho.

Site Number	Site Name	From	To	Number of Recordings
12305500	Boulder Creek near Leonia, ID	1928-06-01	1977-10-05	17447
12305000	Kootenai River at Leonia, ID	1928-03-25	2003-09-30	27583
12306000	Kootenai River at Katka, ID	1928-01-02	1960-09-30	2374
12306500	Moyie River at Eastport, ID	1929-09-01	2003-09-30	27058
12307000	Moyie River at Snyder, ID	1911-03-10	1923-09-30	2930
12307500	Moyie River at Eileen, ID	1925-10-01	1978-11-03	19392
12309000	Cow Creek near Bonners Ferry, ID	1928-05-16	1934-09-30	1365
12309500	Kootenai River at Bonners Ferry, ID	1928-04-01	1960-09-30	11871
12310100	Kootenai River @ tribal hatchery near Bonners Ferry, ID	2002-10-01	2003-09-30	365
12311000	Deep Creek at Moravia, ID	1928-05-01	1971-10-14	15872
12311500	Snow Creek near Moravia, ID	1928-05-08	1934-09-30	1411
12312000	Caribou Creek near Moravia, ID	1928-05-09	1934-09-30	1402
12313000	Myrtle Creek near Bonners Ferry, ID	1928-05-08	2002-09-30	1586
12313500	Ball Creek near Bonners Ferry, ID	1928-05-10	1979-10-04	4580
12315200	Rock Creek near Copeland, ID	1928-05-08	1934-09-30	1440
12315400	Trout Creek near Copeland, ID	1928-05-28	1934-09-30	1244
12315401	Inflow to Kootenai River – branch 1	1988-04-16	1988-04-18	3
12316800	Mission Creek near Copeland, ID	1958-09-01	1981-10-01	8432
12317000	Mission Creek at Copeland, ID	1928-05-09	1934-09-30	1422
12317500	Brush Creek near Copeland, ID	1933-10-01	1934-09-30	226
12318500	Kootenai River near Copeland, ID	1929-05-01	1992-09-30	23164
12318501	Kootenai River, slope/combination	1978-10-02	1979-10-01	282
12319500	Parker Creek near Copeland, ID	1928-05-12	1934-09-30	1303
12320500	Long Canyon Creek near Porthill, ID	1930-10-01	1959-09-30	10592
12320700	Smith Creek below diversion near Porthill, ID	1989-10-01	1992-10-31	1126
12321000	Smith Creek near Porthill, ID	1928-05-12	1960-09-30	11472
12321001	Inflow to Kootenai River – branch 5	1988-04-16	1988-04-18	3
12321500	Boundary Creek near Porthill, ID	1928-05-17	2003-09-30	27174
12322000	Kootenai River at Porthill, ID	1928-10-01	2003-09-30	27393

Table information was obtained from http://nwis.waterdata.usgs.gov.

The largest Idaho tributary systems to the Kootenai River include the Moyie River, Deep Creek, Boundary Creek, and Boulder Creek. Annual discharge in the Idaho tributaries averages 2 cfs per square mile of drainage. The Moyie River drains approximately 192 square miles in Idaho, while the Kootenai River drains approximately 1,140 square miles in Idaho and a total area of 13,700 square miles before leaving Idaho near Porthill. The

Kootenai River has a mean annual discharge of nine million acre-feet and a flow rate at its mouth of just under 30,650 cubic feet per second (cfs).

As the Kootenai River passes through Idaho it gains a total of 1,956 cfs. Entering Idaho near Leonia, the Kootenai River has an annual flow of 13,917 cfs. The USGS has operated a gauging station (12305000) at this location since 1928. When the Kootenai River enters back into Canada, near Porthill, Idaho, its mean annual discharge is 15,874 cfs and has been gauged since 1928 (12322000). Peak discharge of the Kootenai River at Porthill occurred on June 1, 1954 at 125,000 cfs, and minimum flow was recorded on February 8, 1936, at 1,380 cfs.

A gauging station on the Moyie River near Eastport, Idaho (12306500) has been in operation since September 1, 1929. Eastport is located near the Idaho-Canada border and is approximately 20 miles upstream from the confluence with the Kootenai River. The annual discharge hydrograph illustrates a spring snow melt event occurring from April through June dominating the stream discharge pattern. A dominating spring snow melt pattern is common of all hydrographs in this region. The lowest flows occur from August through September. The mean annual discharge of the Moyie River at this location is 692 cfs.

The Eileen, Idaho gauging station (12307500) is located approximately 15 miles downstream from Eastport, and was in operation from August 1, 1925 to November 3, 1978. The mean annual discharge of the Moyie River at this location, for the period of record, was 886 cfs, a net increase of 192 cfs from the Eastport gauging station. This increase is attributed to headwater streams and ground water inflow entering the river throughout its reach. Peak discharge of the Moyie River at Eileen occurred on May 21, 1956 at 9,860 cfs, and minimum flow was recorded on January 2-8, 1937 at 50 cfs.

Several main tributaries enter the Kootenai River upstream of the confluence with the Moyie River. Long Canyon Creek (30 square miles) joins the Kootenai River approximately two miles south of the Canadian border. Long Canyon Creek was gauged by the USGS (12320500) from October 1930 through September 1959 and in that period contributed an annual flow of 63 cfs. Boundary Creek (85 square miles) near Porthill empties into the Kootenai River in Canada. Boundary Creek has been gauged in Idaho since 1928 (12321500), offering a long-term record, and adds a mean annual flow of 201 cfs.

Water quantity trends were analyzed in the Lower Kootenai and Moyie Subbasins by determining the residual flows of the Kootenai River at Porthill, Idaho, Moyie River at Eastport, Idaho and Boundary Creek near Porthill, Idaho. These selected locations represent stream flows from within the basin. Residual flow was calculated by subtracting the actual discharge for each date from the average daily stream flow. This calculation highlights any trends in the basin of water quantity gain or loss. Values were plotted and a trendline was applied to help determine water quantity. Stream discharge records indicate that water quantity is variable. Presently the basin is experiencing a period of gradual decline in water quantity. Periods of water quantity loss are typically followed by periods of water quantity gain.

The Kootenai River is impounded twice before its confluence with the Columbia River. The Libby Dam near Libby, Montana was constructed in 1973 for flood protection and hydroelectric power production. Discharge from the Libby Dam can range from 3,990 cfs to 27,015 cfs depending on power demand. Prior to the construction of the Libby Dam the

Kootenai River's annual discharge at Porthill, Idaho was 16,064 cfs. After the completion of the dam, the river's mean annual discharge was regulated to 15,580 cfs, an approximate difference of 484 cfs. Major flooding events in the Kootenai River valley occurred in 1916, 1948, and 1956. With the completion of the Libby Dam discharge has become more consistent, resulting in higher low flows and lower high flows, consequently the threat from overbank flooding has become minimal.

The Corra Linn Dam, the second impoundment of the Kootenai River, is located 16 miles upstream from the Columbia River and was constructed in 1931, creating Kootenay Lake. The Corra Linn Dam was constructed to produce hydroelectric power and has an average annual discharge of 27,965 cfs. From the Corra Linn Dam, the Kootenai River passes through five hydroelectric dams before emptying into the Columbia River. The Kootenai River is the second largest tributary to the Columbia River in volume and the third largest in drainage area.

2.4.2. Water Column Data

Water samples have been collected by the USGS on the Kootenai River near Porthill, Idaho since 1949. Prior to 1998 water quality data collected at this location consisted of temperature and specific conductance. From 1998 through 2001, pH, dissolved oxygen levels, and nutrient data were also collected intermittently. BURP data has been collected in multiple watersheds during the summer and early fall, outlining habitat and biological parameters. DEQ has collected temperature data, using data loggers, at 70 sites in the Lower Kootenai and Moyie River Subbasins.

Water quality samples collected near Porthill, Idaho on the Kootenai River are displayed in Table 10. Water quality data collected at the Porthill gauge station (12322000) form 1998 through 2001 indicates good water quality, displaying no exceedance of water quality standards. It is difficult to draw an accurate conclusion of tributaries to the Kootenai River based on the data gathered at the Porthill gauging station (12322000). BURP data gathered in the tributaries to the Kootenai River were analyzed to determine the status of beneficial uses.

Table 10. Water quality samples taken at Porthill, Idaho gauge station (12322000).

Sample Date	Water Temp (ºC)	Inst. Discharge (cfs)	Specific Conduct (µs/cm) @ 25ºC	pH (standard Units)	Nitrogen, Ammonia Dissolved (mg/L as N)	Nitrogen, Ammonia + Organic Total (mg/L as N)	Nitrogen, Nitrate + Nitrite Dissolved (mg/L as N)	Phosphorus Total (mg/L as P)	Phosphorus Ortho Dissolved (mg/L as P)	Dissolved Oxygen (mg/L)
01/09/96	4.5	29800	226							
03/07/96	2.5	17000	221							
04/30/96	7	30300	197							
05/30/96	13	47700	161							
07/29/96	18	10400	198							
04/13/98	5.7	9310	164	7.5	0.04	0.10	0.06	0.01	0.01	11.5
05/28/98	10	44800	147	7.6	0.06	0.26	0.08	0.07	0.01	10.4
06/23/98	13.5	26700	202	8.1	0.11	0.38	0.05	0.23	0.01	10.6
07/15/98	16.5	9190	198	8.1	0.05	0.10	0.09	0.01	0.02	10
08/26/98	14.4	17600	229	8.3	0.03	0.10	0.10	0.01	0.01	12.3
10/01/98	13.1		231	8.1	0.02	0.10	0.17	0.05	0.01	9.8
04/04/01	5.5	5270	239	8	0.017	0.19	0.063	0.006	0.007	3.2
05/22/01	9.6	10500	122	7.9	0.002	0.04	0.046	0.007	0.007	7.3
06/27/01	16.2	5940	193	8.1	0.009	0.08	0.014	0.006	0.007	9.1
07/30/01	17.9	6600	235	7.6	0.002	0.11	0.025	0.005	0.007	8
08/27/01	18	6460	241	7.9	0.004	0.10	0.026	0.004	0.007	8.7
09/24/01	15.9	6450	245	8.4	0.008	0.11	0.009	0.005	0.007	9.4

2.4.2.1. Dissolved Oxygen

Dissolved oxygen minimum standards require 6 mg/L dissolved oxygen to support cold water aquatic life and 5 mg/L intergravel and 6 mg/L surface dissolved oxygen levels to support salmonid spawning, No stream segment in the Lower Kootenai or Moyie River Subbasins are on the 1998 §303(d) list for dissolved oxygen limitations. Dissolved oxygen standards are satisfied in the Lower Kootenai and Moyie River Subbasins.

2.4.2.2. pH

Blue Joe Creek, from the headwaters to the Canadian border, is listed for pH exceedance (When pH is higher than our upper criteria (9.5) ore less than our lower criteria (6.5).. Cold water aquatic life use and salmonid spawning beneficial use support requires a pH of between 6.5 and 9.5.

2.4.2.3. Metals

Blue Joe Creek, from the headwaters to the Canadian border, is currently listed on the 1998 §303(d) list for metals exceedances. The specific metals of concern in Blue Joe Creek are lead, zinc and cadmium. The major sources for metals in Blue Joe Creek occur from seepage and leaching of tailings piles from the Idaho Continental Mine's tunnel number 5 (Mitchell 2000). The Continental Mine is located approximately five miles above Blue Joe's confluence with Boundary Creek, and was active from the 1890s to the 1950s. High discharge events have transported many of the tailings downstream.

Environmental cleanup activities have been completed and Blue Joe Creek is considered recovering. More details are in the Key Findings portion of the Executive Summary, and in section 2.4.5.

The toxicity of dissolved metals in the water column is dependent on the hardness (calcium carbonate (mg/L) in the water) of the water in question. Toxicity of metals to aquatic life increases as hardness decreases. For this reason hardness based water quality criteria are most stringent at low hardness levels. A stream's water hardness value can be related to flow, as flow decreases hardness increases. This means that as flow rates decrease water quality criteria for metals increase. Idaho sets a minimum hardness to be used in calculating the criteria at 25 mg/L (Idaho Water Quality Standards).

Idaho water quality standards for allowable metals concentrations have two parts. Chemical criteria are defined in terms of concentrations and the frequency and duration of allowable exceedances of these concentrations. Concentrations are usually defined as maximum and average concentrations. A criterion maximum concentration (CMC) "acute" criterion is the one hour average concentration not to be exceeded more than once every three years. A criterion continuous concentration (CCC) "chronic" criterion is the four-day average concentration not to be exceeded more than once every three years. The following hardness based equations have been established in the state of Idaho water quality standards:

- Dissolved Cadmium Criteria:

Criterion Continuous Concentration

$(1.101672-[\ln(\text{hardness})(0.041838)])*(\exp[0.7852(\ln(\text{hardness}))-3.490])$

Criterion Max Concentration

(1.136672-[ln(hardness)(0.041838)])*(exp[1.0166(ln(hardness))-3.924])

- Dissolved Lead Criteria:

Criterion Continuous Concentration

(1.46203-[ln(hardness)(0.145712)])*(exp[1.273(ln(hardness))-4.705])

Criterion Max Concentration

(1.46203-[ln(hardness)(0.145712)])*(exp[1.273(ln(hardness))-1.46])

- Dissolved Zinc Criteria:

Criterion Continuous Concentration

0.986exp[0.8473(ln(hardness))+0.884]

Criterion Max Concentration

0.978exp[0.8473(ln(hardness))+0.884]

Hardness values in the Kootenai River vary with geographic location, time of year, and discharge. The overall mean hardness of the Kootenai River is 93 mg/L (measured by Bauer in 1998, Kootenai River Water Quality Study). Seasonal low hardness values occurred in May with an overall average hardness value of 70 mg/L. Metal toxicity is dependent on the hardness of the river, so 70 mg/L should be used as the overall value when calculating criteria. Hardness values of the Moyie River are considerably lower than the Kootenai River with an overall mean of 18.5 mg/L (Bauer 1998).

Hardness values for tributaries to the Kootenai River are dramatically lower than those measured in the Kootenai River. The overall median hardness value for the Kootenai River tributaries is 15 mg/L (Bauer 2000). Some tributaries in the subbasin exhibit consistently higher hardness values, but using the lower value of 15 mg/L is more conservative (protective) of aquatic resources (Bauer 2000). When determining the toxicity of the metal concentrations in a stream it is important to evaluate each stream individually, associating a hardness value for each stream. Based on these hardness levels and available data, only Blue Joe Creek was found to exceed Water Quality Standards.

2.4.2.4. Nutrients

No stream segments in the Lower Kootenai and Moyie Subbasins are listed for nutrients. Water samples collected at USGS gauge station 12322000 near Porthill, Idaho indicate no exceedances of water quality criteria for nutrients. Idaho water quality narrative criteria states that "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." No obvious sources of nutrient impairment are noted in the subbasins. Snyder and Minshall (1996) and Richards (1997) have suggested that the Libby Dam may act as a nutrient trap, resulting in low nutrient values in the Kootenai River. However, this may not explain the low levels of nutrients in the river, as tributaries in Idaho also appear to be low in nutrients. It has been speculated that the geologic setting may be a poor nutrient producer.

2.4.2.5. Temperature

Deep Creek and Boundary Creek are EPA temperature additions to the 1998 §303(d) list. DEQ has monitored temperature in the subbasin using temperature data loggers, during the time frame that captures the hottest period of the year when stream temperatures are likely to exceed standards.

Two temperature loggers were deployed on Deep Creek from July through October in 1998 and in 2000, and from May through October in 2001. A full season of Deep Creek temperatures taken near Ruby Creek in 2000 (Figure C-5 in Appendix C) shows violations of cold water aquatic life criteria 26% of the time, and violations of spring and fall salmonid spawning criteria over 90% of the time. During roughly the same time period (late July to early September) in 2000, temperatures recorded by temperature data loggers in nearly the same place in Deep Creek are shown in Figures C-6 through C-10 in Appendix C. Temperature data loggers were placed approximately 0.5m from each other, thus they represent replicates of each other. There is little difference among the data from these loggers. All temperature data from the Deep Creek loggers show violations of fall salmonid spawning criteria 100% of the time. It is not known how much of Deep Creek's temperature profile is the result of discharge from McArthur Lake, which is a shallow, warm water lake.

From July through October in 1998, 2000 and 2001 two temperature recorders were deployed in Boundary Creek. A full season of Boundary Creek temperatures taken at the lower end near the United States Geological Survey (USGS) gage station revealed that cold water aquatic life criteria were met in 2000, but spring salmonid spawning criteria were violated 27% of the time and fall salmonid spawning criteria were violated as much as 81% of the time. Partial season recordings (during 1998 and 2001) of Boundary Creek temperature (Figures C-2 through C-4 in Appendix C) also show violations of fall salmonid spawning criteria to a similar degree (50-60% of the time), including at one upper site where Boundary Creek enters Idaho from Canada (Figure C-2 in Appendix C). Temperature differences between the upper site (Figure C-2) where Boundary Creek enters Idaho (3,400 ft elevation) and the lower site (Figure C-3) near the USGS gage (1,800 ft elevation), during the same time period in 1998, show an average difference of $1.6^{o}C$ (with a range of 3.8^{o} to $-0.6^{o}C$).

2.4.3. Biological and Other Data

Stream macroinvertebrate index (SMI), stream fish index (SFI) and stream habitat index (SHI) scores for streams in the Lower Kootenai and Moyie River Subbasins are compiled in Table 11. As described in DEQ's WBAG II (Grafe et al. 2002), indices are based on the Northern Mountain Ecoregion. A minimum of two indices are required to make a support determination. An average value of 2 or greater generally indicates support of cold water use, and a value lower than two indicates nonsupport. At least two indices must be available for assessment. Scoring criteria is outlined in Table 12.

Table 11. BURP Sites and Index Scores for Lower Kootenai and Moyie River Subbasins.

Stream Name	BURP ID	ASSESSMENT UNIT	Stream Macro-invertebrate Index	Stream Fish Index	Stream Habitat Index
Ball Creek	1998SCDAB043	ID17010104PN011_02	64.72	64.80	83.00
Blue Joe Creek	1995SCDAA070	ID17010104PN004_02	46.36	No Fish	63.00
Boulder Creek	1995SCDAA074	ID17010104PN032_03	37.55	NA	37.00
Boulder Creek	1994SCDAA057	ID17010104PN033_03	80.27	82.14	45.00
Boulder Creek	1995SCDAA073	ID17010104PN033_03	35.47	NA	59.00
Boundary Creek	1995SCDAB043	ID17010104PN002_02	44.52	82.92	52.00
Boundary Creek	1999SCDAA011	ID17010104PN002_02	34.65	NA	76.00
Boundary Creek	1999SCDAA012	ID17010104PN002_03	45.09	25.12	49.00
Boundary Creek	1995SCDAB044	ID17010104PN002_03	28.33	NA	49.00
Boundary Creek	1999SCDAA013	ID17010104PN002_03	39.67	NA	75.00
Brown Creek	1995SCDAB046	ID17010104PN027_03	36.80	NA	48.00
Canuck Creek	1998SCDAB058	ID17010105PN007_02	61.46	80.00	62.00
Canuck Creek	1994SCDAA058	ID17010105PN007_02	77.02	95.00	64.00
Caribou Creek	1994SCDAA033	ID17010104PN017_02	54.99	91.48	26.00
Cascade Creek	1998SCDAB044	ID17010104PN014_02	63.04	NA	80.00
Copper Creek	1998SCDAB059	ID17010105PN006_02	58.80	NA	56.00
Cow Creek	1995SCDAB041	ID17010104PN006_02	50.75	66.08	66.00
Cow Creek	1998SCDAB053	ID17010104PN030_03	48.95	41.91	50.00
Curley Creek	1998SCDAB054	ID17010104PN035_03	21.70	15.49	40.00
Deep Creek	1995SCDAA072	ID17010104PN019_04	40.50	46.41	40.00
Deep Creek	1995SCDAA071	ID17010104PN022_03	32.65	NA	36.00
Deer Creek	1994SCDAA059	ID17010105PN004_03	54.48	98.42	59.00
Deer Creek	1998SCDAB062	ID17010105PN004_03	82.61	NA	70.00
East Fork Meadow Creek	1995SCDAB042	ID17010105PN012_02	67.14	41.19	69.00
Fall Creek	1998SCDAB050	ID17010104PN021_03	30.01	45.05	44.00
Gillon Creek	1998SCDAB060	ID17010105PN009_02	60.21	72.72	64.00
Grass Creek	1998SCDAB033	ID17010104PN003_02	66.37	NA	83.00
Grass Creek	1998SCDAA016	ID17010104PN003_03	70.79	57.14	75.00
Grass Creek	1994SCDAA034	ID17010104PN003_03	47.51	73.45	29.00
Kreist Creek	1997SCDAA020	ID17010105PN005_02	62.75	NA	72.00
Long Canyon Creek	1998SCDAA015	ID17010104PN008_02	51.32	54.85	82.00
Long Canyon Creek	1994SCDAA029	ID17010104PN008_02	50.85	72.69	43.00
Meadow Creek	1994SCDAA012	ID17010105PN012_03	62.20	61.96	50.00
Middle Fork Boulder Creek	1999SCDAA010	ID17010104PN033_02	65.69	NA	87.00
Mission Creek	1994SCDAA035	ID17010104PN040_03	52.48	88.86	66.00
Myrtle Creek	1994SCDAA032	ID17010104PN013_03	45.68	72.18	46.00

Stream Name	BURP ID	ASSESSMENT UNIT	Stream Macro-invertebrate Index	Stream Fish Index	Stream Habitat Index
Myrtle Creek	1998SCDAB047	ID17010104PN013_03	64.13	NA	75.00
Parker Creek	1994SCDAA030	ID17010104PN009_02	61.70	99.21	25.00
Placer Creek	1994SCDAA011	ID17010105PN002_02	75.09	80.28	69.00
Raymond Creek	1998SCDAA012	ID17010101PN001_02	66.58	88.81	80.00
Rock Creek	1998SCDAB041	ID17010104PN037_02	34.55	NA	67.00
Round Prairie Creek	1994SCDAA010	ID17010105PN010_02	46.46	52.81	50.00
Round Prairie Creek	1997SCDAA021	ID17010105PN010_02	28.76	NA	39.00
Ruby Creek	1997SCDAA019	ID17010104PN020_02	66.46	NA	74.00
Ruby Creek	1994SCDAA037	ID17010104PN020_03	56.85	75.09	48.00
S Callahan Creek	1994SCDAA056	ID17010101PN003_03	80.06	82.92	57.00
Skin Creek	1998SCDAB063	ID17010105PN003_02	76.53	NA	78.00
Smith Creek	1994SCDAA036	ID17010104PN005_04	65.93	NA	49.00
Smith Creek	1998SCDAB042	ID17010104PN007_03	62.00	47.69	73.00
Snow Creek	1995SCDAA069	ID17010104PN016_02	60.21	58.29	52.00
Snow Creek	1995SCDAA068	ID17010104PN016_03	53.93	70.58	60.00
Trail Creek	1998SCDAB052	ID17010104PN026_03	65.49	NA	48.00
Trout Creek	1994SCDAA031	ID17010104PN010_03	46.88	90.27	60.00
Trout Creek	1998SCDAB055	ID17010104PN010_03	83.31	NA	85.00
Twentymile Creek	1995SCDAB045	ID17010104PN028_02	63.42	82.34	60.00
Wall Creek	1996SCDAA011	ID17010105PN012_02	56.78	NA	75.00

Table 12. SMI, SFI and SHI scoring criteria

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above the 25th percentile of reference condition	≥65	≥81	≥66	3
10th to 25th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34		Minimum Threshold

2.4.4. Status of Beneficial Uses

The WBAG II (Grafe et al. 2002) describes DEQ’s methods for determining beneficial use support. The only uses considered in this report are the aquatic life beneficial uses, including cold water aquatic life, salmonid spawning, and bull trout where appropriate. Cold water aquatic life use support is determined by water quality criteria compliance and multimetric indexes calculated from macroinvertebrate, fish, and physical habitat monitoring data. Each index includes several characteristics to gauge ecosystem health from BURP compatible data. The multimetric index value is a summation of the individual metrics that respond to environmental degradation. The stream macroinvertebrate index (SMI), stream fish index (SFI), and stream habitat index (SHI) scores for each site are then assigned a condition rating based on percentiles of their respective reference conditions. Condition ratings from the available indexes are then averaged to give an indication of the overall cold water aquatic life use support status. In addition to looking at biological indices, support for salmonid spawning and bull trout aquatic life uses is determined through numeric temperature criteria compliance.

The primary external factors impacting the Kootenai River basin fish and wildlife resources come from the mainstem Columbia River federal hydropower operations, which profoundly influence dam operations as far upstream as headwater reservoirs. Dam operations affect environmental conditions in the reservoirs upstream and rivers downstream from Libby Dam. The abundance, productivity, and diversity of fish and wildlife species inhabiting the subbasin are dependent on their immediate environment that ebbs and flows with river management.

Mainstem Columbia River operations affect native fish and wildlife in the following ways:

- Unnaturally high flows during summer and winter negatively impact resident fish.
- Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This impacts productivity in the reservoirs.
- Drafting the reservoirs excessively prior to receiving the January 1 inflow forecast places the reservoirs at a disadvantage for reservoir refill. This is especially important during less-than-average water years.
- Flow fluctuations caused by power generation requirements, flood control, or fish flows create a wide varial zone in the river (subject to periodic air exposure and inundation), which becomes biologically unproductive.
- The planned reservoir-refill date of June 30, in the National Oceanic and Atmospheric Administration (NOAA) Fisheries Biological Opinion, will cause the dam to spill in roughly the highest 30% of water years. This is because inflows remain above turbine capacity into July on high years. That means the reservoirs fill and have no remaining capacity to control spill, which causes gas super-saturation problems.
- Flow fluctuations caused by power generation requirements, flood control, or fish flows cause sediments to build up in river cobbles. Before dams were built, these sediments normally deposited themselves in floodplain zones that provided the seedbeds necessary for establishment of willow, cottonwood, and other riparian plant communities. Young cottonwood stands are needed to replace mature stands that are being lost to natural stand aging as well as adverse human activities such as hardwood logging and land clearing.

2.4.5. Conclusions

In-stream and aerial water temperature data show exceedances of temperature criteria for bull trout and salmonid spawning throughout the basin. Higher order tributaries (larger streams) also exceed cold water aquatic life temperature criteria. The limited distribution of bull trout in the basin may reflect the insufficient availability of cold water necessary to support bull trout life requisites for fall spawning and summer rearing. All of the water bodies in the Lower Kootenai and Moyie Subbasins are therefore recommended to be included in future temperature TMDLs for the Lower Kootenai and Moyie River Subbasins.

Sediment impacted streams are more difficult to identify. The lack of numeric criteria for sediment requires a more direct measure of beneficial use support. When comparing sediment loads to macroinvertebrate index scores, scores generally fall below the full support threshold when sediment loads exceed 50% of background. Waters that are §303(d) listed for sediment and have sediment loads in excess of 50% of background include Cow Creek, Deep Creek, and the Moyie River. These waters and their tributaries are to be included in the sediment TMDL. Waters that were not listed on the §303(d) list for sediment, but produce sediment in excess of 50% of background are recommended to be evaluated in the next assessment cycle.

Water quality criteria for metals were exceeded in Blue Joe Creek at the time of this assessment. Because of water quality improvement projects that have already been implemented, it is expected that Blue Joe Creek will meet all designated uses within a reasonable timeframe. Metals TMDLs are therefore deferred and listing as category 4b in Idaho’s next Integrated Report is recommended. It is also recommended that additional data be collected in Blue Joe Creek for determination of compliance with the pH criteria.

2.5. Data Gaps

Many of the waters in the Upper Kootenai, Lower Kootenai, and Moyie River Subbasins are classified as “unassessed.” Streams that have not had BURP monitoring include Smith, West Fork Smith, Cutoff, Bear, Lost, Dodge, South Fork Dodge, Curley, Kingsley, Fleming, Bane, Rock, Mission, Little Hellroaring, and Miller Creeks. Continued BURP monitoring will eventually close this data gap and allow for better spatial representation of biological information within the basin.

The major data gap in temperature monitoring is the lack of temperature data for the entire length of stream. Most temperature data recorders were deployed near or at the mouths of the streams. In order to make a more accurate assessment, a temperature profile for the entire watershed should be prepared. Further deployment of data loggers and improved deployment protocols will eventually reduce this data gap.

Data gaps in sediment pollution monitoring stem from the lack of in-stream sediment measurements and information outlining sediment transport for the basin. Nonpoint sources have been modeled rather than measured. In-stream monitoring of sediment load would be of value. Such monitoring is expensive and it is unlikely that this data gap will be filled. Model results continue to be the best available information at this time.

When modeling sediment loading to watersheds, cumulative watershed effects (CWE) road scores were used when available. Idaho Code Section 38-1303 (17) defines cumulative watershed effects as “…the impact on water quality and/or beneficial uses which result from the incremental impact of two or more forest practices. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.” The CWE methodology is designed to examine conditions in the watershed surrounding a stream first, and then in the stream itself. It then attempts to identify the causes of any adverse conditions. Finally, it helps to identify actions that will correct any identified adverse conditions.

Not all watersheds in the basin had applicable CWE road scores associated. Further development of this coverage would help to more accurately define sediment problems. As with BURP monitoring, this data gap will most likely be filled in the future.

3. Subbasin Assessment–Pollutant Source Inventory

Sources of nutrients, bacteria, and dissolved oxygen demanding materials are not apparent in the Lower Kootenai and Moyie River Subbasins. All sources of sediment are non-point sources. Sources of thermal input are restricted to loss of stream canopy cover.

3.1. Sources of Pollutants of Concern

Pollutant sources of sediment are discussed in the following sections. Sediment is yielded to the subbasin from a large number of sources, including natural erosion. Activities in the subbasin such as forest activities, agriculture, and urban development are all sources of pollutants in the subbasin. Agriculture activities are limited to the flat fields in the floodplain and some upland areas with relatively flat topography. The upland agriculture areas have a higher sediment delivery potential than those restricted to the floodplain. Sources of dissolved oxygen demanding materials are not apparent.

3.1.1. Point Sources

There are no Superfund or Resource Conservation Recovery Act (RCRA) sites in the subbasin. The City of Bonners Ferry holds the only two NPDES permits in Boundary County (ID-002022-2), issued November 5, 1998, for wastewater and water treatment systems.

3.1.2. Nonpoint Sources

Nonpoint sources of sediment are discussed for the next several pages under the heading Sediment Sources, followed by a brief descriptions of nonpoint sources of thermal modification, in section 3.1.2.2, Temperature Sources.

3.1.2.1. Sediment Sources

Natural erosion processes noted as occurring within the Lower Kootenai and Moyie River Subbasins include hillslope creep, mass failure, and surface erosion. A common land type in the basin is gently to moderately sloping glaciated land, derived from granitics. In CWE assessments, this land type is considered to have a high inherent hazard for surface erosion and a moderate inherent hazard for mass failure. Such occurrences contribute large volumes of sediment to the stream.

The historic cycle of large wildland fires is normally considered as an event followed by significant short-term sedimentation pulses to streams. However, it is thought by some USFS hydrologists and soil scientists that historic, large stand replacing fires on the west side of the basin may not have greatly led to accelerated surface erosion because of the volcanic ash cap below the organic duff layer (Niehoff, personal communication). The ash cap is very porous and allows rapid water infiltration into the shallow groundwater stratum. Instead, intense fires may have produced a glazing effect on the ash cap, creating a hydrophobic condition. This condition accelerates water runoff, along with the open canopy from fire, but without a pronounced surface erosion scouring effect. Particularly during episodic precipitation, snowmelt, and flood events following a large fire, excess water runoff would have resulted in excessive stream energy, along with log debris dams, leading to significant stream bed cutting and bank erosion. Current instream degradation in the way of sediment accumulation, pool filling, and channel widening of some west side streams are in part attributed to large stand replacing fires.

Prior to the Idaho Forest Practices Act (FPA), timber harvesting on private land was unregulated. Early and mid-twentieth century timber harvesting was both in burnt and disease/insect affected areas for salvage logging, and in lands of unburned, mature growth stands for selective harvest of high value species such as white pine, spruce, hemlock and cedar. During this time there was construction of railroad lines and spurs, flumes and chutes, and a network of transportation roads, skid trails, jammer roads and spurs, and stream crossings. Some of the early transportation system was built close to streams, and within the streams themselves (chutes and flumes). In some areas there were clear-cuts of cedar and hemlock within riparian zones. IDL and USFS land managers consider that these early practices led to a significant yield of sediment to basin streams and that impairment within some basin streams still reflect these legacy practices.

Timber harvesting under the Idaho FPA (in effect since 1974), incorporates best management (BMP) standards for road building, harvesting design and extraction methods, stream crossings, maintenance, and the establishment of a stream protection zone (SPZ). Still, as harvesting continues to be a major activity in the basin, there is ongoing disturbance and compaction of forest soils and ephemeral swales by heavy machinery, skidding, and construction of new roads, stream crossings, and landings. In addition to unpaved roads as a known significant sediment source, there are also tractor excavated skid trails where the tractor blade scrapes and removes the volcanic ash cap (Niehoff, personal communication). There are a significant number of small blocks of forested acres in the basin that are privately owned and logged, collectively called Non-Industrial Private Forest (NIPF). Harvesting activities on these lands fall within the regulations of the FPA as administered by IDL. Forest audits conducted by a team of experts indicate that NIPF land owners generally have more departures from BMPs than found on public and industrial lands (IDL et al. 1993).

Roads

Roads built to facilitate timber harvest and other activities can be significant sources of sediment. A road system in forested lands includes: the road surface along with water runoff management structures such as rolling dips and cross culverts; down gradient fillslopes and up gradient cutslopes; drainage ditches; and stream crossings. Road systems produce sediment mass and a percentage of that mass can be delivered to basin streams. A common observed and measured feature of road segments is high variability in the mass of sediment produced, and many road segments produce little sediment but a few segments produce a large amount (Luce and Black 1999). The forested road density in the Lower Kootenai River basin is generally moderate to high, ranging from 2 – 7 mi/mi2 in many fifth order watersheds.

Sediment production from the road surface will vary according to such factors as inherent erodibility and runoff producing capacity of the soil and running surface, degree of gravel capping, road gradient and road segment length, sufficiency and maintenance of water runoff management structures, and road use. Road surface erosion may be accelerated by rut formation when vehicles travel the road during the wet, spongy conditions of spring thaw and peak runoff. Sediment production from the road surface and other parts of the road system does not equate to sediment yield to a stream. The ratio of production to yield often depends on the sediment exit point in proximity to stream locale, including the area of intervening forest floor which serves to function as a sediment trap settling area (Megahan and Ketcheson 1996).

Sediment production also comes from fillslopes and cutslopes. The cutslopes can contribute sediment to drainage ditches through soil creep, sheet wash, rilling, and slumping. A cutslope can intercept the shallow subsurface flow of forested floors, and this groundwater will surface and weep at the cutslope, at times accelerating erosion and slumping.

Mass failures occur along road systems, often more frequently than the mass failure rate in undisturbed forests. Mass failures have been partially inventoried in the basin, and overall they occur at a relatively low frequency.

Some basin watersheds have a significant length of road within 300 ft of perennial streams. These stream-course roads may be on steep benches where there is some distance to the stream, but steep slopes provide little sediment settling function and there is direct runoff to the stream. There are also stream-course roads along low gradient valleys which encroach into the riparian and floodplain zones. Besides the high potential of direct sediment yield to streams, these roads can also lessen the function of floodplains by both decreasing flooded area and reducing the degree of stream meander. In some basin watersheds, estimates of riparian road density are as high as 10 - 15 mi/mi2 riparian area (Panhandle Bull Trout TAT 1998a).

The overall trend in the basin of public agency and timber industry roads is a gradual reduction of the road network mileage. Some roads have been closed, abandoned, and/or obliterated; old jammer roads have become brushed in; and new road networks are more efficiently designed and maintained.

Private residential road density is increasing in the basin as land is converted from timber to rural home sites. When these roads are inventoried it is clear that many of them do not meet the standards of FPA roads. They are often not capped with gravel, they tend to become heavily rutted, and thus frequently graded which produces loose soil, and they do not have sufficient water runoff management structures when built on steep slopes. Homes along stream courses are often desired by homeowners, and thus overall, there is a high potential of sediment delivery from residential private roads to streams.

For all road types, sediment yield to streams on a per area basis is generally highest at stream crossings. Sediment production from the road system that approaches stream crossings can be delivered directly, unless there is a good system of pre-crossing runoff diversion, and a presence of structures such as sediment traps or check dams within the approaching ditch line. Gravel armoring of road approaches is another method of reducing sediment yield. Stream crossing culverts can be undersized, or become damaged or plugged, leading to cutslope, road segment, and fillslope failures into the stream. Excessive velocity from culvert discharges can gouge out the downstream channel, which in turn can leave a sufficient drop between the culvert lip and stream bed to prevent upstream fish migration.

Frequency of stream crossings is high in parts of the basin, reaching two crossings/mile of perennial stream. Inventoried crossings in the basin range from: well maintained, proper functioning, with BMPs such as gravel armor at the aprons and sediment traps within approaching ditches; to poorly functioning and maintained stream crossings with obvious high sediment erosion and slumping, along with stream bed damage downstream of the culvert discharge.

Agriculture

Alfalfa cropping on private lands occurs within the basin. For the most part, this activity produces only minor amounts of sediment export except during times of periodic tillage. There are stream segments within private agriculture land in the floodplain that in the past have been straightened. Also, drainage channels have been constructed in surrounding wet soil lands to expedite the spring drainage of water and subsequent tending to crops. By eliminating stream meander and creating channelized draining, stream energy increases to the point of widening and damaging stream banks, greatly increasing sediment yield. Occasionally, there is mechanical re-deepening of cross drainage channels, and for the short term this greatly increases sediment delivery to the parent stream.

Cattle grazing occurs on private lands as well as federal and state range allotments. There are several observed stream sections where direct cattle access has severely damaged stream banks and eliminated riparian vegetation needed for bank stability and stream shading. In areas where cattle have direct access to streams, there also is potential for fecal coliform pollution.

Urbanization

Urban sources of sediment include runoff from access roads, driveways, disturbed hillslopes, and particularly, new excavation and construction activities. Also observed is the removal of vegetation from stream riparian zones not regulated by the FPA (no commercial sale of timbered logs).

Home site development in the basin is often comprised of 5 - 20 acre “ranchettes,” which frequently include small numbers of large grazing animals that often have free access to streams running through private property.

Bank Erosion

In-stream bank erosion can be a significant source of sediment. From recorded field observations and results of the stream bank erosion survey, it is known that stream bank erosion can be a significant direct sediment contributor to basin streams. There are reaches along main stems of Rosgen C and F channel types with one or two confining banks that are at times high and steep. Areas have been documented where super saturated clay banks are eroding and sloughing, as well as unconsolidated sand-gravel-cobble banks. At times this is a natural condition related to insufficient root stabilizing vegetation. But there are observations where the condition has been obviously exacerbated by historic riparian logging, adjacent road fills, cattle access, and ATV, and four-wheel drive vehicle access.

Because some amount of bank erosion sediment is understood to be background, there is a natural background component built into the model.

It is extremely difficult to partition current stream bank erosion rates to related factors such as: 1) naturally occurring; 2) remnants of effects from historic fires followed by increased flows; 3) remnant effects of historic timber harvesting in the riparian zone and construction of a transportation network; 4) excess stream energy of peak flows related to hydrologic openings from timber harvesting; 5) channel straightening and conversion of wetlands and wet meadows for agriculture purposes; 6) excess current sediment loads which leads to a decrease in stream depth; and 7) the effect of floodplain encroaching roads, as the road can interfere with the stream's natural tendency to seek a steady state gradient, and at high discharge periods may cause the stream to erode stream banks and the stream bed.

3.1.2.2. Temperature Sources

The primary disturbance causing stream temperatures to rise is non-natural canopy modification by silvicultural and agricultural practices. Attainment of natural full potential canopy shade is the most that can be done to lower stream temperatures. This TMDL uses an approach that involves potential natural vegetation (PNV), which is further described in section 5.1.2.1.

3.1.3. Pollutant Transport

In this subbasin, pollutant transport is only relevant to sediment. Sediment is delivered to the stream system primarily during high precipitation-high discharge events or rapid snowmelt events. These are episodic events. Under these conditions, large volumes of sediment move in the stream systems. These conditions develop stream power and stage heights capable of channel alteration. Sediment trapped in upper low order watersheds moves quickly to the higher order streams of the subbasin. Streams with a steep gradient, constrained by roads, exhibit rapid erosion from the bed and banks.

3.2. Data Gaps

The major data gap in sediment pollution is not related to sources, but is related to in-stream measurements of load and transport of sediment. The major data gap in temperature pollution is the lack of temperature logger data from the entire length of the stream. Presently, most temperature profiles are created based on temperature data collected at or near the mouth of the stream.

3.2.1. Point Sources

No point discharges of sediment, heat, nutrients, bacteria, or oxygen demanding materials have been documented.

3.2.2. Nonpoint Sources

3.2.2.1. Sediment

Nonpoint sources of sediment have been modeled rather than measured. In-stream measurements of the sediment load would be of value. Such monitoring is expensive. It is unlikely that this data gap will be filled. Model results are the best available data.

3.2.2.2. Temperature

Current temperature data was collected from in-stream monitoring at set locations.

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4. Summary of Past and Present Pollution Control Efforts

The Idaho Forest Practices Act (FPA) governs the harvest and reforestation of all timberlands in Idaho. These rules are, in part, requirements for best management practices (BMPs) designed to abate erosion and retard sediment delivery to the stream. The Idaho Department of Lands (IDL) has implemented the act's rules and regulations aggressively over the past 15 years. Currently, the majority of the forested lands in the Lower Kootenai and Moyie River Subbasin are managed by the state or federal government. This large state and federal ownership helps to ensure that the rules and regulations of the FPA are implemented.

All harvests managed by the U.S. Forest Service (USFS) must meet INFISH (the federal Inland Native Fish Strategy) guidelines. These guidelines prescribe 300-foot wide buffers for streams with fish uses. Current and proposed timber sales within the basin include various road projects aimed at improving water quality. Road projects include road obliteration, resurfacing, slope stabilization, stream crossings, and drainage improvements.

4.1. Forestry

The FPA is state policy and is legislatively mandated. A Forest Practices Advisory Committee composed of various interest groups has been established with the specific responsibility to review and improve forestry BMPs such that forest practices will be conducted using the latest economically sound information and practices to protect water quality. The Committee conducts research into forest practice questions and gathers information from various sources, effectively providing a feedback loop for continuous improvement of forest practices. Many of the activities now being implemented in the Lower Kootenai River Subbasin to improve water quality are the direct result of improved practices and BMPs put in place by the FPA.

The FPA was codified during the mid-1970s to comply with Section 208 of the federal Clean Water Act (CWA). The FPA established mandatory rules and regulations leading to BMPs to be used during forest practices to protect surface water quality (IDL 1998). Espinosa et al (1997) described estimated sediment delivery in amounts greater than USFS management plan goals from the 1950s through the 1970s, and noted that the awareness of watershed and habitat degradation problems helped to initiate a moderation of timber and road construction impacts in the early 1980s. On-site audits of FPA compliance were conducted in 1978, 1984, 1988, 1992, 1996, 2000, and 2004. Because of these audits, BMPs have been revised to promote better water quality protection.

Under the FPA, the forest industry and the State of Idaho have developed and are implementing a cumulative watershed effects (CWE) process for forest lands in Idaho. The goal of this methodology is to systematically examine forested watersheds and identify on-the-ground cases where forest management may be contributing to water quality problems as defined by the CWA and state standards. When problems are identified, the process leads directly to corrective management prescriptions where the problem is occurring. CWE assessments have been completed on a significant portion of the Lower Kootenai River Subbasin (including 80% of the Deep Creek drainage). CWE reports define corrective management actions where on-the-ground conditions have been documented. These actions include BMPs based on FPA guidelines to ensure that forestry activities are not impairing water quality conditions. DEQ has been working closely with the FPA committee, IDL, and private industry to ensure BMPs are implemented, and will continue to do so.

4.1.1. Idaho Department of Lands

The Idaho Department of Lands (IDL) performs a variety of pollution control efforts in the Lower Kootenai River Subbasin. These efforts include enforcement of FPA rules, FPA education, Stewardship Forestry Assistance, Stewardship Cost-Share Programs, general forestry education, management of State endowment lands, and administration and enforcement of the Minerals Act. The FPA requires forest landowner compliance with forestry BMPs. Approximately 500 logging compliances are issued annually out of the Kootenai Valley Area office in Bonners Ferry, Idaho (2004), and approximately 200 inspections of logging operations are performed each year to ensure compliance with the FPA. These on-site inspections include review of road construction and maintenance, stream crossing construction, stream protection zone encroachment by equipment, and road/skidtrail locations. Stewardship Forestry Assistance includes on-site visits with landowners providing education, information and technical training on forestry and stream-side BMPs. The State administers the Stewardship Program which includes assistance to landowners through cost sharing forestry, riparian, and agroforestry practices. The department also supports the Logger Education and Professionalism Program and Pro-Logger Program by providing workshops and training in the areas of logging BMP and FPA rules. Topics presented in 2003 included "Installing Culverts to Meet Fish Passage Guidelines." In 2004, presentations to logger groups covered Forest Practices rules regarding skid trail location and maintenance.

The IDL administers approximately 24,500 acres of endowment land within the Deep Creek watershed for the purpose of generating revenue for the trust beneficiaries (primarily public schools, the University of Idaho, and charitable institutions). Administration of this land meets and exceeds the FPA rules. In August of 2004, the local supervisory area voluntarily implemented the terms of the **Idaho Forestry Program**, **Snake River Basin Adjudication (SRBA).** These terms include increased operational restrictions within riparian protection zones, and stringent road construction, reconstruction, design, and maintenance requirements that exceed the current Idaho FPA BMP requirements with the intent of providing additional protection for threatened and endangered species of fish (including bull trout, which are present in the Kootenai River drainage). Stream crossing structures are engineered to meet 50-year peak flows. Roads are inventoried and inspected on a periodic basis. Pollution (sediment and temperature) management problems are identified and repaired as soon as weather conditions and funding permit.

From the time of the initial 1998 §303(d) list until now (2005), the IDL, in conjunction with cooperating large industrial forest landowners, has undertaken a number of capital improvement projects expressly to reduce potential sediment generation from existing forest roads. These include applying crushed rock surfacing and/or drainage upgrades on the following roads: Trail Creek (4.82 miles); Mutiny Point (13.0 miles); Beaver Lake (1.07 miles); Contrary Creek (1.01 miles); Trail Creek S. 17 (0.36 miles); North Bloom Lake (1.5 miles); Twentymile Peak (5.0 miles); and Highland Creek (3.23 miles).

In addition to the 30 miles of road improvements listed above, the IDL has permanently abandoned approximately two miles of substandard spur road. The IDL also routinely regulates public access and limits purchaser use of roads using a variety of closure measures at times when potential is great for damage to running surface water, in order to control erosion and sediment production. Purchasers of timber sales are required to maintain active roads over the duration of individual contracts. Inactive sale roads are identified and erosion control measures installed seasonally and/or prior to cancellation. At other times, the IDL uses dedicated monies collected from timber sale purchasers to fund completion of contract and/or State-crew deferred road maintenance projects in order to keep drainage structures operational and correct problems as they are detected.

4.2. Agriculture

The lowland portion of the basin, the Kootenai River floodplain, is largely owned by private parties. Agriculture practices in the valley consist of growing spring and winter wheat and canola, spring barley, timothy, white clover, and hops. In the bench areas, spring and winter wheat, spring barley, alfalfa hay and seed, and grass hay are grown. Some livestock grazing does occur within the basin. Current watershed improvement projects include fencing and hardening of livestock stream crossings, riparian vegetation restoration, and bank stabilization.

In 1979 the original Agricultural Pollution Plan (Ag Plan) was developed in response to Section 208 of the Clean Water Act and represents the agricultural portion of the State Water Quality Management Plan. Subsequently the plan has been revised in 1983 and 1991. The most current Ag Plan, *Idaho Agriculture Pollution Abatement Plan, 2003*, sets goals and provides guidance for the management of all nonpoint source related activities throughout the state.

Proposed and currently implemented pollution control efforts will help restore water quality. Field observations note that implemented projects have been generally effective in the basin. Further development and implementation of pollution control efforts will help to achieve water quality standards within a reasonable time. Pre- and post-implementation monitoring will help to determine the prolonged effectiveness of pollution control efforts.

According to the 2000 United State Department of Agriculture (USDA) Soil Survey of Boundary County Area, Idaho:

> About 68,000 acres in the survey area is used for crop production and hay and pasture. Major crops are spring wheat, winter wheat, oats, barley, alfalfa, clover seed, and canola. Ornamental nursery production and irrigated hops make up a small but significant acreage. Most of the cropland is located on the Kootenai River floodplain, which has been drained and protected from flooding by a system of ditches, pumps, and levees. The remainder of the cropland and most of the hay land and pasture is located on the high benches of cleared forestland. Some of the pasture is located on wet bottom lands and meadows along the major creeks of the area.
>
> Timber production is carried out by both individual landowners and large timber companies.

> Livestock grazing is becoming more important to the area's economy. Livestock operations include cow-calf or beef enterprises, generally less than 100 cows. Some of the large timber companies lease out their cutover timberlands for livestock grazing. Some of the federal- and state-owned lands are also leased out for livestock grazing. The average size of individual farms and ranches in the area is about 300 acres. Large corporate timberland tracts range in size from 1,000 to over 10,000 acres.

The Boundary Soil Conservation District was formed on December 6, 1947, and is the Designated Management Agencies (DMA) in charge of guidance and program implementation for private and state agricultural lands. Originally, the purpose of the district was to conserve the soil resources of Boundary County, but it has expanded to include conservation and development of all natural resources.

4.2.1. Agronomy

General management needed for crops and pasture is suggested in this section. The estimated yields of the main crops and pasture plants are listed, the system of land capability classification used by the Natural Resources Conservation Service is explained, and prime farmland is described.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

4.2.2. Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the USDA. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the USDA recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our nation's prime farmland.

The USDA defines prime farmland as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pasture, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6%. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

Table 13 lists projects within the Lower Kootenai and Moyie Subbasins provided by the Boundary County Soil Conservation District.

Table 13. Projects within the Lower Kootenai and Moyie River Subbasins.

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
Ruby Creek, bank barbs, tree and shrub planting, riprap. Funded/owner	NA	Reduce bank erosion, increase shading	Improve water quality	17010104PN020_02 17010104PN020_03
Conservation Reserve Program (CRP), Planting permanent cover on approximately 1200 acres.	1985 through present	Eliminated sheet and rill erosion	Good soil conservation practice	17010104PN020 17010104PN050
Conservation Tillage Systems, educed tillage and direct seeding systems.	1985 through present	Reduce sheet/rill erosion	Keep crop residues on soil surface	17010104PN040 17010104PN050
Rock Creek, Hydro Seeding project with ITD. Permanent grass, legume/shrub mixture. Highway 95	1996	Excellent cover for erosion control	Plants well established	17010104PN037_02 17010104PN037_03
Curley Creek, riparian project, riparian fencing and hardened livestock crossing/grazing system.	1996	Good riparian vegetation recovery	Reduced livestock bank trampling	17010104PN035_02 17010104PN035_03
Ruby Creek, road stabilization culvert replacement and rock armor on shoulder. Funded by EWP/(5) landowners	1996-97	Reduce sediment delivery to stream	Improve water quality	17010104PN020_02 17010104PN020_03
Fall Creek, stabilization rock rip rap rock, stream bank stabilization,	1997	Reduce sediment	Improve water quality	17010104PN021_02 17010104PN021_03

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
protected local community well. Funded by EWP				
Fall Creek road stabilization. Rock gabion structures reduce road bank erosion. Funded by EWP	1997	Reduce road bank sloughing	Improve Fall Creek water quality	17010104PN021_02 17010104PN021_03
Twenty Mile Creek, stabilization, funded by EWP	1997	Reduce stream bank erosion	Improved water quality	17010104PN027_03 17010104PN028_02
Deep Creek, install toe rock, stabilize Deep Creek stream bank. funded by EWP	1997	Reduce stream bank erosion	Improve water quality	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L 17010104PN025_02
Brown Creek, bridge stabilization reinforce bridge washout, funded by EWP	1997	Rock rip rap	Reduce sediment; improve water quality	17010104PN027_02
Ruby Creek, road stabilization ¾ mile repair. Repair massive road slump and erosion. Funded by EWP	1997	Rock armor and seeding	Reduce sediment	17010104PN020_02 17010104PN020_03
Kootenai River, bank stabilization, funded by EWP disaster of flooding with large snow pack year.	1997	Eliminated bank sloughing	Bank erosion eliminated, Need woody plantings	17010104PN031_08 17010104PN029_08 17010104PN012_08 17010104PN001_08
Round Prairie Creek, Restore wetland hydrology. Funded by WRP	1998	Restore riparian and meadows	Improved wildlife habitat	17010104PN008_03 17010104PN010_02 17010104PN010_03
Deep Creek, stream bank stabilization, reduce stream bank erosion. Funded by EQIP	1998	Restore riparian and meadows	Improved wildlife habitat	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
				17010104PN025_02
Animal Waste Systems: Reduce animal waste run off and reduce nutrient pollution into water bodies. Store animal wastes. Funded by EQIP.	1998 and 2003	Eliminate manure run off	Excellent water quality benefit	NA
Deep Creek, bank barbs, rip rap, log revetment, and set-back fencing. Funded by EQIP.	1999 and 2000	Bank erosion eliminated; reduced sediment	Log revetment trap sediment	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L 17010104PN025_02
North Hill hydro seeding project with ITD along Highway 95.	2000	Bank erosion eliminated; reduced sediment	Log revetment trap sediment	NA
Boundary Creek, WRP(Deon Hubbard) Restore Kootenai River floodplain wetlands and hydrology. Funded by USDA WRP	2000	Restored hydrology; Enhanced wildlife habitat	Floodplain flood storage; enhance riparian vegetation	17010104PN002_02 17010104PN002_03
Deep Creek, log revetment structures along outside bend. EQIP funded Jeff Ennis	2000	Restored hydrology; Enhanced wildlife habitat; Pole plantings	Floodplain flood storage; enhance riparian vegetation 70% survival poles	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L 17010104PN025_02
Bane Creek, tree and shrub plantings. approximately 3000 trees and shrubs planted per year in logged over areas within watershed.	2000-2004	Improve watershed and shading of drainages	Improve overall small watershed health	17010104PN036_02
Smith Creek, dike road repair-rock rip	2002	Reduced bank erosion	Stream bank armored	17010104PN007_02 17010104PN007_03

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
rap, Bio-eng. and rock barbs. Funded USDA WRP		and sediment.		
Curley Creek, WRP restore riparian and associated semi wet meadows. Restore, floodplain hydrology	2002	Enhanced riparian zones. Recharge groundwater	Flood control; enhanced hydrology	17010104PN035_02 17010104PN035_03
Kootenai drain ditch and creeks, CRP filter strip under continuous sign up. Permanent cover along drain ditches and creeks	2002 through present	Reduce surface pollutants	Fair to good shading along water bodies	17010104PN031_08 17010104PN029_08 17010104PN012_08 17010104PN001_08
Cow Creek, tree and shrub plantings. Planting trees and shrubs within watershed WHIP/FIP funded	2002-2003	Improve watershed and shading	Improve overall watershed health	17010104PN030_02 17010104PN030_03
Curley Creek, tree and shrub planting and forest, road seeding SWCA funded	2002-2004	Reduce forest and watershed erosion	Improve riparian	17010104PN035_02 17010104PN035_03
Kootenai River, WRP restore floodplain wetlands and hydrology. Funded by USDA WRP	2003	Reduce forest and watershed erosion	Improve riparian	17010104PN031_08 17010104PN029_08 17010104PN012_08 17010104PN001_08
Ball Creek, WRP restore Kootenai River floodplain wetlands and hydrology. Funded by TNC, USFWS, and USDA WRP program	2003	Restore floodplain hydrology	Enhance wildlife habitat	17010104PN011_02
Animal waste systems. Waste systems designed	2003-2004	Reduce animal waste run off	Improve water quality	17010104PN050

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
waiting Funded by EQIP				
Trail Creek, stream bank and shoreline protection. Funded by EQIP	2004	Reduce bank erosion	Proposed willow and rock armor	17010104PN026_02 17010104PN026_03
Deep Creek, bank barbs, rip rap, brush revetment, set-back fencing, and tree and shrub plantings on bank- 300 linear feet of bank total. Funded by EQIP	2005	Eliminate bank sloughing, increased shading	Brush revetment. traps sediment, fencing eliminates livestock bank trampling	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L 17010104PN025_02
Deep Creek (2) shallow wildlife ponds and willow plantings, WHIP/landowner funded	2005	Surface runoff retention, pollutant filtering	Tansy population onsite will also be reduced; enhanced wildlife habitat	17010104PN015_04 17010104PN018_04 17010104PN019_04 17010104PN022_03 17010104PN023_0L 17010104PN025_02
Unnamed tributary Kootenai River, (2) wildlife ponds WHIP/landowner funded	2005	Surface runoff retention	Enhance wildlife habitat	17010104PN-
Long Canyon Creek, stream bank and shoreline protection, 600 linear feet EQIP Special Projects/landowners funded	2006	Reduce bank erosion, increase shading, enhance fish habitat	Proposed riparian forest buffer with bioengineering and some toe rock	17010104PN008_02
Cow Creek, prescribed grazing (30 acres), pasture and hayland planting (30 acres), forest management (60 acres), wildlife ponds EQIP/landowner	2006-2010	Reduce sheet and rill erosion	Reduced soil compaction, improve plant vigor, reduce fuel loads, improve forest health	17010104PN030_02 17010104PN030_03

Project Description	Date Implemented	Effectiveness	Comments	Assessment Unit
funded				
Conservation cover, grass and legumes in rotation hay crops planted approx. 5000 acre/year planted	On going	Reduced sheet/rill erosion	Good soil quality; improve soil tilth	17010101-030-060

5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1. In-stream Water Quality Targets

In-stream water quality targets are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.1. Sediment TMDL In-stream Water Quality Targets

This TMDL addresses sediment in the Cow Creek and Deep Creek watersheds. Deep Creek is also on the 1998 §303(d) list for temperature which is discussed separately throughout this section. The in-stream water quality target for the Cow and Deep Creek sediment TMDL is full support of the cold water aquatic life designated uses (Idaho Code 39.3611, .3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The sediment TMDL will develop loading capacities in terms of mass per unit time. The interim goals will be set based on conditions in other watersheds supporting the cold water use and the final goals will be established when biomonitoring demonstrates full support of the cold water use. The sources yielding sediment to the system can be reduced, but a substantial period (up to 30 years) will be required for the stream to clear its current sediment bed load and create pools.

5.1.2. Temperature TMDL In-stream Water Quality Targets

For the Deep Creek and Boundary Creek temperature TMDLs, DEQ is utilizing a potential natural vegetation (PNV) approach. According to Idaho water quality standards (IDAPA 58.01.02.200.09), if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature resulting from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. See Appendix B for further discussion of water quality standards and background provisions. The PNV approach is detailed below, including the procedures and methodologies for developing PNV target shade levels and estimating existing shade levels. For a more complete discussion of shade and its effects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (DEQ 2004, available online at http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/clearwater_river_sf/clearwater_river_sf.cfm).

5.1.2.1. Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The parameters that affect or control the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are

factors influencing shade that are most likely to have been influenced by anthropogenic activities, and which can most readily be corrected and addressed by a TMDL.
Generally, riparian vegetation provides a substantial amount of shade on a stream only when it is very close to the stream, however, vegetation further away from the riparian corridor can provide shade depending on how much vertical elevation surrounds the stream.

DEQ can determine the amount of shade a stream enjoys by using one or both of the following types of measurements:

- **Effective shade**, which is the shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade.
- **Canopy cover** is a similar parameter that affects the amount of solar radiation a stream receives. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or can be estimated visually either on site or using aerial photography.

Both these methods provide us information about how much of the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is the intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in any way. The PNV believed to have existed before any disturbance can be considered a basis for comparison. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind using PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream. DEQ can estimate PNV from models of plant community structure and can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what can be done to decrease solar gain.

Existing shade or cover was initially estimated for Boundary Creek (U.S. portion) and Deep Creek (McArthur Lake to mouth) from visual observations of aerial photos. These estimates were then field verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology). The PNV targets were determined by analyzing probable natural vegetation at these two creeks and comparing it to shade curves developed for similar vegetation communities in other TMDLs. A shade curve shows the relationship between stream width and effective shade. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the plant community is able to provide more shade at any given channel width. Existing shade and PNV shade were converted to solar load from data collected on flat plate collectors at the nearest National Energy Research Laboratory weather stations that collect these data. In this case, an average from the two nearest stations (at Kalispell, Montana and Spokane, Washington) was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though in stream temperature information may exceed numeric criteria.

5.1.2.2. Pathfinder Methodology

The solar pathfinder is a device that allows a person to trace the outline of shade-producing objects on charts already printed with monthly solar paths. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. In order to adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location the solar pathfinder should be placed in the middle of the stream about one foot above the water and the manufacturer's instructions for taking traces followed, including orienting it to true south and leveling. Systematic sampling is easiest to accomplish without biasing the location of sampling. To systematically choose sampling locations, start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g., every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer). Randomly located points of measurement can also be chosen by generating random numbers to be used as interval distances.

It is a good idea to take notes while taking solar pathfinder traces, and to photograph the stream at several unique locations, paying special attention to changes in riparian plant communities and noting the kinds of plant species (the large, dominant, shade producing ones) are present. Additionally or as a substitution, a person can take densiometer readings, to measure canopy cover at the same location as solar pathfinder traces are taken to measure effective shade. This provides the potential to determine relationships between canopy cover and effective shade for a given stream.

5.1.2.3. Aerial Photo Interpretation Methodology

In this method, canopy coverage estimates or expectations of shade based on plant type and density are provided for 200-foot elevation intervals, or natural breaks in vegetation density, marked out on a 1:100K topology map. Each interval is assigned a single value representing one of the shade classes specified in the chart below. There are ten shade classes, one for every 10% interval – all values within a 10% range are assigned the smallest value in the range. For example, if canopy cover for a particular stretch of stream is estimated to be between 50% and 59%, the value of 50% is assigned to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. The typical vegetation type (below) shows the kind of landscape a particular cover class usually falls into. For example, if a section of stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, as it does on very wide streams.

Cover class	Typical vegetation type
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 –19%	agricultural land, meadows, open areas, clearcuts
20 = 20 – 29%	agricultural land, meadows, open areas, clearcuts
30 = 30 – 39%	agricultural land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

It is important to note that the visual estimates made from the aerial photos are of canopy cover, not shade. DEQ assumes that canopy coverage and shade are similar based on research conducted by Oregon DEQ (OWEB 2001). The visual estimates of cover in this TMDL were field verified with solar pathfinder measurements of shade. The pathfinder measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, man-made structures). The estimate of cover made visually from an aerial photo does not take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

5.1.2.4. Stream Morphology

Measures of current bankfull width or near stream disturbance zone width may not reflect widths that were present under PNV conditions. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase as streams become wider and shallower. Shadow length produced by vegetation covers a smaller percentage of the water surface in wider streams. Widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

Shade target selection, which involves evaluating the amount of shade provided at PNV conditions, necessitates determination of potential natural stream widths as well. In this TMDL appropriate stream widths for shade target selection were determined from analysis of existing stream widths and the relationship between drainage area and width-to-depth ratios (Rosgen 1996). See Appendix B for more discussion on determining appropriate stream widths. Because the majority of the Boundary Creek watershed is in Canada, and because the watershed is relatively unaltered, its existing stream widths (23m) are used in the target selection process.

The drainage area for Deep Creek is roughly 181 mi^2 with 129 mi^2 above Brown Creek. Deep Creek natural stream widths below Brown Creek (Rosgen C type) were likely in the neighborhood of 20m (66ft) as determined from Figure B-2 (in Appendix B). Existing stream widths were measured to be about 25m at the second lowest pathfinder verification site (i.e., the second to the last site going downstream, or second upstream from the mouth of the creek), which is within this section of Deep Creek.

The drainage area for McArthur Lake and Deep Creek above Trail Creek is about 41 mi^2. Therefore, natural stream widths from McArthur Lake to Brown Creek (Rosgen C type) were determined from Figure B-2 to be about 10m (33ft). Existing stream widths, measured within this stretch at various BURP and pathfinder sites, range from 8.9m to 19m with an average of about 13m (43ft). Thus, existing stream widths are slightly larger than the natural stream width determined for this section of the creek. One complication in the process of determining natural stream width is that the effects of McArthur Lake and its human-made control structures are unknown.

At the mouth of Deep Creek, high water backing up from the Kootenai River affects the size of the near stream disturbance zone visible in Figure 23. Hence, natural channel widths at the mouth are altered by inundation. Although Figure B-2 in Appendix B suggests that natural channel widths for the mouth of Deep Creek should be in the neighborhood of 23-25m, the existing near stream disturbance zone at the mouth (Figure 23) is about 60m. DEQ chose to use the existing near stream disturbance zone width of 60m for the target width at the mouth of Deep Creek, because it was assumed that the inundation process, caused by downstream dam operations, was not controllable or reversible.

5.1.3. Design Conditions

Design conditions are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.3.1. Sediment TMDL Design Conditions

All sources of sediment to Cow Creek and Deep Creek are nonpoint sources. This TMDL addresses the nonpoint sediment yield to the watershed. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with critical conditions. These events typically occur between November through May, but may not occur for several years. The typical return time of the largest events is 10-15 years (DEQ 2001). The critical stream reaches are the Rosgen B channel types that naturally harbor the most robust cold water communities, but have gradients sufficiently low for coarse bedload to accumulate and fill pools. The key to nonpoint source sediment management is to implement remedial activities prior to the advent of a large discharge event. Large discharge events are the only mechanism of transporting coarse sediments downstream.

5.1.3.2. Temperature TMDL Design Conditions

Design conditions for the temperature TMDL are divided into those for Boundary Creek and those for Deep Creek.

5.1.3.2.1. Boundary Creek – Potential Natural Vegetation

Boundary Creek flows from west to east through the very tip of the Idaho panhandle. Boundary Creek enters Idaho from British Columbia, Canada on the west end, flows approximately 6.5 miles eastward through the Panhandle National Forest, then leaves the National Forest and flows about 0.5 miles through private land before it enters a linear channel on the Canadian side of the border just prior to entering the Kootenai River.

The majority of this watershed is forested. Although not mapped in the Boundary County Soil Survey (Chugg and Fosberg 1980), soils on the north-facing southern side of Boundary Creek are likely to be of the Pend Orielle-Idamont association. These glaciated mountainsides support a potential natural community of western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*), with lesser amounts of grand fir (*Abies grandis*), Douglas fir (*Psuedotsuga menziesii*), western white pine (*Pinus monticola*), and western larch (*Larix occidentalis*). Soils on the south-facing northern side of Boundary Creek are likely of the Rock outcrop-Treble complex. Soils of the Treble series are found on southwest facing glaciated mountainsides, and support a Douglas fir (*P. menziesii*), ponderosa pine (*Pinus ponderosa*), and snowberry (*Symphorocarpus sp.*) community (Chugg and Fosberg 1980). Soils outside the national forest boundary near the mouth of Boundary Creek are Bane loamy fine sand typically found on alluvial fans at the mouths of steep canyons (Chugg and Fosberg 1980). Potential natural vegetation on these soils include ponderosa pine, Douglas fir, black cottonwood (*Populus trichocarpa*), and pinegrass (*Calamagrostis sp.*).

5.1.3.2.2. Deep Creek – Potential Natural Vegetation

Deep Creek generally flows south to north from McArthur Lake to the Kootenai River. For most of its length, riparian soils along Deep Creek are Seelovers silt loam (Chugg and Fosberg 1980). The potential natural vegetation associated with this soil was mixed deciduous trees and shrubs with some occasional conifers. Trees included black cottonwood, paper birch (*Betula papyrifera*), western red cedar, and Douglas fir (Chugg and Fosberg 1980, Jankovsky-Jones 1996). Shrubs likely included red osier dogwood (*Cornus sericea*), mountain alder (*Alnus incana*), Douglas hawthorn (*Crataegus Douglasii*), chokecherry (*Prunus virginiana*), and various willows (*Salix sp.*) (Jankovsky-Jones 1996). Deep Creek bottomland where the creek enters the Kootenai River floodplain is underlain by Farnhamton silt loam soils, and supported a black cottonwood gallery forest with deciduous shrubs (willows) and occasional conifers (Douglas fir) (Chugg and Fosberg 1980).

5.1.4. Target Selection

Target selection is discussed separately for the sediment TMDL, which includes discussion of modeling sediment yield from a disturbed landscape, and the temperature TMDL.

5.1.4.1. Sediment TMDL Target Selection

The TMDL applies sediment allocations in tons per year and calculates sediment reduction goals.

The load capacity rate at which full support is exhibited has been set at various levels in TMDLs developed by DEQ. These have ranged from setting an interim load capacity at the background level for some watersheds in the Coeur d’Alene Lake Subbasin and the Pend Oreille basin, to more than 200% above background in some areas of the state. Evidence is beginning to support that a target of 50% above background is protective of the beneficial uses in the Lower Kootenai and Moyie River Subbasins. This target is far more conservative (protective) when compared to previously set load capacities of other Panhandle TMDLs. Similar rationale used in previous TMDLs can be used to support the more conservative target.

The rationale supplied in those TMDLs in support of the target was based on several premises (DEQ 2001):

- Sediment yield less than 50% above background will fully support the beneficial uses of cold water aquatic life and salmonid spawning.
- Beneficial uses (cold water aquatic life and salmonid spawning) will be fully supported when the finite but not quantified ability of the stream system to process (attenuate) sediment is met.

Data collected within the Lower Kootenai River Subbasin appears to support the target of 50% above background. A comparison of WBAG II scores to the modeled percentage above background estimates for sediment is shown in Figure 21. In the green shaded area, the two coincide: the WBAG II score indicates full support (not impaired) and the modeled percentage above background is less than 50%. The two also coincide in the red shaded area: the WBAGII scores indicate the stream is impaired and the modeled percentage above background is greater than 50%.

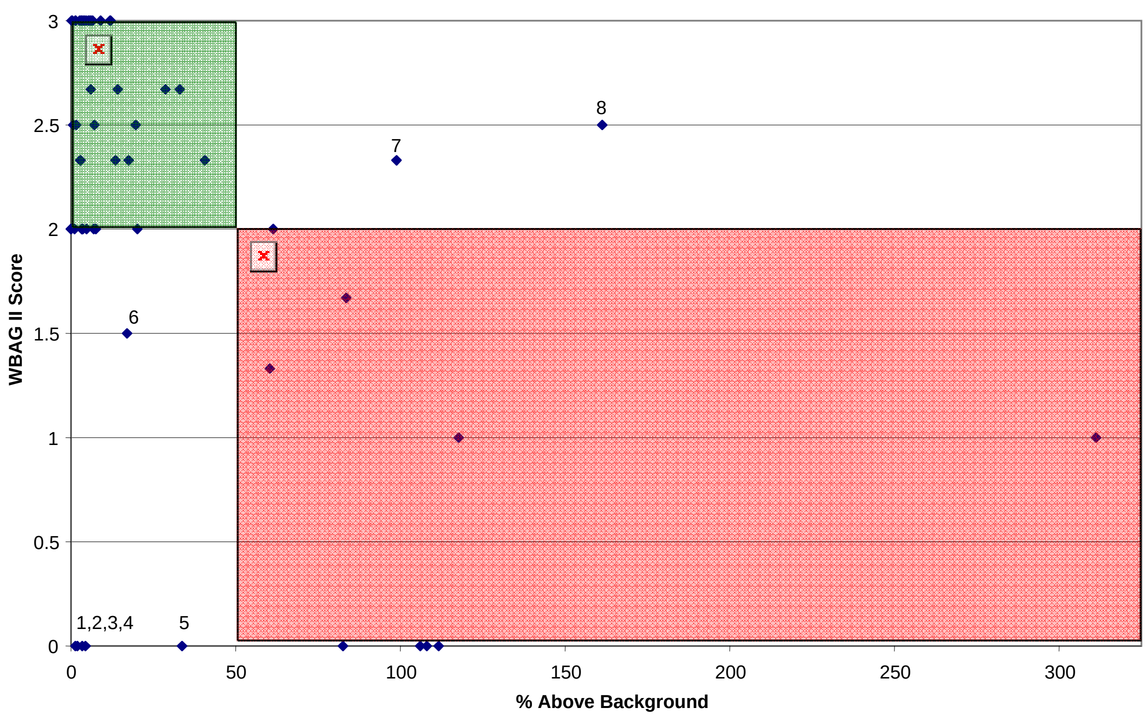

Figure 21. Sediment WBAGII scores versus modeled percentage above background

For the eight cases in which the two do not coincide (points labeled 1-8 on Figure 21), the notes below describe conditions at each site.

1. Boulder Creek (1995SCDAA074): large substrate size: difficult to collect representative macroinvertebrate sample. Large substrate size may also contribute to poor macroinvertebrate habitat.
2. Boulder Creek (1995SCDAA073): large substrate size; difficult to collect representative macroinvertebrate sample. Large substrate size may also contribute to poor macroinvertebrate habitat.
3. Boundary Creek (2001SCDAE034): downstream from Blue Joe Creek, which is §303(d) listed for metals and pH. Metals and pH exceedances are contributing to a low WBAG II score for Boundary Creek.

4. Rock Creek (2001SCDAA003): 1st order stream with very low flows (0.1 cfs). Low flows inhibit the development of a sustainable macroinvertebrate community, without a macro community a food chain is unable to develop, which affects the fish population.
5. Fisher Creek (2001SCDAA023): bedrock substrate resulting in less than ideal sampling conditions and a lack of sufficient macroinvertebrate habitat.
6. Blue Joe Creek (1995SCDAA070): also listed for pH and metals exceedances. Metals and pH exceedances are adversely affecting macroinvertebrate and fish communities.
7. East Fork Meadow Creek (1995SCDAB042): watershed maybe unaffected by sediment, therefore unresponsive to changes in sediment delivery.
8. Highland Creek (2001SCDAA046): watershed maybe unaffected by sediment, therefore unresponsive to changes in sediment delivery.

In all but the eight instances for which conditions are described above, the WBAG II score and the percentage of background sediment coincide. Watersheds where they do not coincide may be affected by conditions other than sediment and may therefore be unresponsive to changes in sediment delivery to the stream. For instance, Blue Joe Creek (point 6 on Figure 21 and note 6) is also listed for pH and metal exceedances, which may be adversely affecting its macroinvertebrate and fish communities, although it is experiencing very little sediment delivered to the stream. Blue Joe Creek has a passing habitat score (in spite of a failing overall/average score); however, no fish were collected and its macroinvertebrate score is low. For Boulder Creek and Fisher Creek (points 1, 2, and 5 on Figure 21 and notes 1, 2, and 5), which also have sediment levels below the 50% above background threshold but have failing WBAG II scores, the failing scores maybe a reflection of difficult sampling conditions. The Boulder Creek substrate consists of large cobble- to boulder-sized particles and in Fisher Creek exposed bedrock may have made macroinvertebrate sampling difficult. In the Fisher Creek watershed, observed natural fish barriers may also be contributing to a low WBAG II score.

According to the evidence outlined above, the 50% above background target appears to be reasonable and protective of the beneficial uses of the watersheds in the Lower Kootenai River Subbasin. Therefore, the target load capacity for sediment in Cow and Deep Creeks is set at 50% above background.

The goal should be attained following three high flow events after implementation plan actions are in place. Based on the average recurrence of high flow events, this should take about 30 years. This time is necessary for the channel-forming events needed to export sediment and to create pool structures.

5.1.4.1.1. Modeling Sediment Yield From a Disturbed Landscape

High and low density development land use designations were developed by interpreting known structure (buildings) locations. A GIS density function was applied to structure locations to determine an appropriate land use distribution. The point density function was used to calculate the density of structures around a specified area. Conceptually, an area is centered on a center cell, and the number of points that fall within the specified area is totaled and divided by the area. Although primitive, this was the best known way to incorporate known but not explicitly identified sediment contributors within the watershed associated with rural development.

An area of approximately one mile diameter was applied to structures in the basin. An area this size is expected to incorporate road networks and other infrastructure associated with development. Changing the radius size would directly affect the outcome of the development land use coverage. More information is needed to determine the appropriate area of impact caused by rural home sites and to adjust the neighborhood radius accordingly.

Once the development coverage was created it was then overlain by an acreage coverage distinguished by land manager. Land uses were assigned to land managers regardless of modeled land use type. In this step land managers may be assigned land use types which are not observed within lands they manage. This edge effect is most commonly observed with high and low density development land use types.

Differentiation between high and low density development was computed based on the number and distance between known structures. A high number of structures in a confined location resulted in a high density development classification. A low number of structures distributed in a broad area received a low density development classification. High density development is generally centered around the towns of Bonners Ferry, Moyie Springs, Porthill, East Port, Naples, and McArthur. Low density development is mostly contained within, but not limited to, the Lower Kootenai and Moyie River valleys

5.1.4.1.1.1. Limitations

The lack of data associated with rural development surface water impacts creates difficulties when trying to model rural development sediment yield. Future monitoring will help to close these data gaps and develop more reliable and realistic sediment reduction goals allocated to high and low density development. Specifically more information is needed on the size of home sites, infrastructure associated with each site, and the nature in which adjacent land is managed. Monitoring and surveying of rural development will also help to define the causes of sediment and how to mitigate against sediment generation to surface water.

5.1.4.1.1.2. Burn/Shrub sediment yield

Similar to the high and low density development sediment yield coefficients, burn/shrub areas identified in the upper Cow Creek watershed were modeled using an unsubstantiated coefficient. Personal knowledge of sediment export, along with comparison of data used to develop other sediment yield coefficients, was collaborated to determine appropriate sediment yield expectations. Additional monitoring would be helpful in determining the most appropriate burn/shrub sediment yield coefficient.

5.1.4.1.1.3. Pipeline sediment yield

Sediment yield to surface water associated with pipelines is limited to construction and is not a chronic source of sediment. Data were supplied to DEQ by Gas Transmissions Northwest pertaining to pipeline crossings causing surface water impacts. A regression analysis was applied to the data in order to determine the most appropriate sediment yield coefficient to be used in the Lower Kootenai and Moyie River Subbasin sediment model. Modeled results indicate that pipeline sediment yield accounts for only 1.7% of the load reductions within the basin. Minor sediment reductions mirror the minor acreage dedicated to the pipeline land use type.

5.1.4.1.1.4. Agriculture sediment yield coefficients

Valley and bench agriculture coefficients were developed using the Revised Universal Soil Loss Equation version 2 (RUSLE2). RUSLE2 was developed to inventory erosion rates and estimate sediment delivery. Valley agriculture areas were modeled to have a lower sediment delivery coefficient than natural background conditions because of an extensive dike system built near the turn of the century. Valley land has been diked and drained to create farmland. The use of dikes in the valley agriculture areas restricts sediment delivery to surface water. One pumping station is located near the Deep Creek confluence with the Kootenai River (personal communication, Scott Bacon 2005). Pumping is conducted to remove water from agricultural areas. Before water is pumped into the Kootenai River, sediment is settled out, resulting in little sediment delivery to the river.

Valley agriculture is modeled to be within the floodplain adjacent to the Kootenai River. Valley agriculture land use type is most notable in the Deep Creek watershed. Valley agriculture land use is noted occurring near the confluence of the Kootenai River in other watersheds on a limited scale.

5.1.4.2. Temperature TMDL Target Selection

To determine potential natural vegetation shade targets for Deep and Boundary Creeks, effective shade curves from several existing temperature TMDLs were examined. These TMDLs had previously used vegetation community modeling to produce these shade curves. For Deep and Boundary Creeks, curves for the most similar vegetation type were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade the stream.

The effective shade calculations are based on a six month period from April through September. However, the critical time period when temperatures affect beneficial uses occurred in June through September when spring and fall salmonids spawning temperatures were exceeded in both creeks and when cold water aquatic life criteria were exceeded in Deep Creek (see temperature data in Appendix C). Late July and early August are the period of highest stream temperatures (however, cold water aquatic life criteria were not violated in Boundary Creek (Figure C-1)). Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but solar loadings affect salmonids spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

5.1.4.2.1. <u>Boundary Creek</u>

For Boundary Creek an attempt was made to match a western hemlock/western redcedar forest type. Although the south-facing side of the canyon is largely Douglas fir/ponderosa pine, the near stream vegetation on the north side is likely more mesic and resembles the south side (see Figure 22).

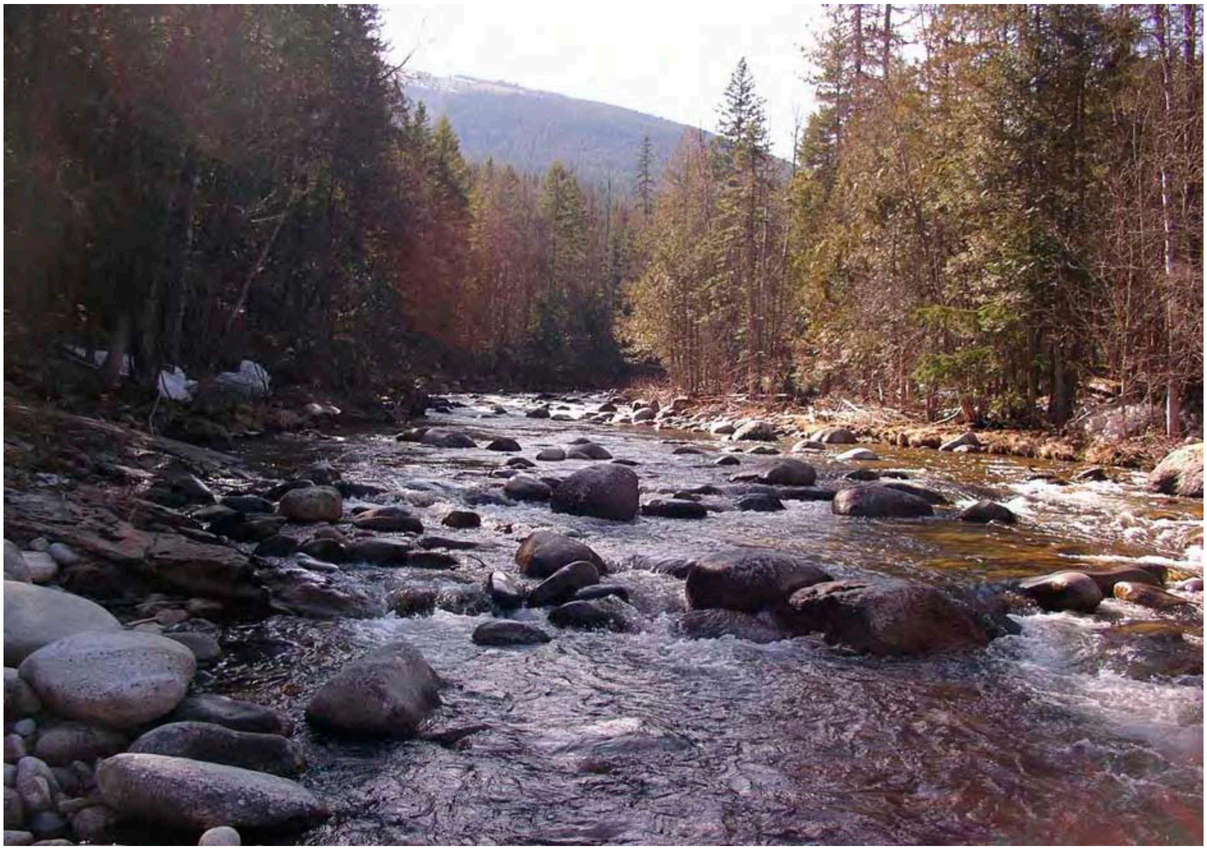

Figure 22. Boundary Creek near stream vegetation.

Effective shade curves from four TMDLs were used. Using an average stream width of 23m (from bankfull width measurements at six BURP sites and recent measurements taken during solar pathfinder sampling in March 2005), the following effective shade levels were observed in these TMDLs:

1. South Fork Clearwater River TMDL (IDEQ 2004), stream breaklands, cedar and grand fir type = 55% effective shade at 23m.
2. Willamette Basin TMDL (ODEQ 2004a), Western Cascade Range geomorphology (Tvw) = 60% effective shade at 23m.
3. Walla Walla River TMDL (ODEQ 2004b), conifer zone = 50% effective shade at 23m.
4. Mattole River TMDL (CRWQCB 2002), Klamath mixed conifer forest = 65% effective shade at 23m.

Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at a 23m stream width were remarkably similar. For Boundary Creek, an average of these four effective shades (58%) was rounded to 60% and selected as the target effective shade level for this TMDL.

5.1.4.2.2. <u>Deep Creek</u>

Deep Creek below McArthur Lake was separated into three reaches for shade target development (see Stream Morphology section 5.1.2.4). The portion above Lake McArthur was not included in the analysis. In the upper evaluated reach, bankfull widths measured at

BURP and other sites averaged about 13m. Because natural widths were likely to be less than present day widths, 10m width was chosen to represent the majority of the watershed from McArthur Lake to about Brown Creek (see previous discussion on stream morphology).

The second reach is about 4.7 miles of stream in a valley that is wider then the rest of the watershed above it. A width of 20m was chosen to represent stream widths in this second reach.

The lowest reach of 1.5 miles on the Kootenai River floodplain was treated as the third reach. The bottomland portion of Deep Creek has channel widths that are substantially larger than those of upper Deep Creek (60m estimated from maps and aerial photos) because of the influence of levees and the Kootenai River. This wider near stream disturbance zone can be seen in the photograph in Figure 23.

Figure 23. Deep Creek bottomland near the Kootenai River. The near stream disturbance zone is larger than banks due to periodic inundation during high flows.

Again, effective shade curves from four TMDLs (three of them the same as those used for Boundary Creek) were used to produce average shade targets for upper, middle and lower Deep Creek. Using average stream widths of 60m for the bottomland, 20m for middle Deep Creek and 10m for upper Deep Creek, the following effective shade levels were observed from these TMDLs:

1. Alvord Lake TMDL (ODEQ 2003), black cottonwood/pacific willow type =

   40% effective shade at 60m
   70% effective shade at 20m
   80% effective shade at 10m.
2. Walla Walla River TMDL (ODEQ 2004b), deciduous-conifer zone =

   30% effective shade at 60m
   60% effective shade at 20m
   70% effective shade at 10m.
3. Mattole River TMDL (CRWQCB 2002), mixed hardwoods-conifer forest =

   30% effective shade at 60m
   68% effective shade at 20m
   82% effective shade at 10m.
4. Willamette Basin TMDL (ODEQ 2004a), alluvium of small streams (Qalf) geomorphology =

   22% effective shade at 60m
   40% effective shade at 20m
   55% effective shade at 10m.

Again, effective shade from differing TMDLs are similar at the same stream width. An average of the effective shade values from these four TMDLs was used for targets in Deep Creek. For the Deep Creek bottomland (lowest 1.5 miles) an effective shade target of 30% was chosen, for the middle portion of Deep Creek the effective shade target is 60%, and for upper Deep Creek, the effective shade target is 72%.

5.1.5. Compliance Points and Monitoring

Compliance points and monitoring are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.5.1. Sediment TMDL Compliance Points and Monitoring

The point of compliance for Cow Creek is approximately three miles above its mouth (BURP ID 1995SCDAB041) and Deep Creek's point of compliance is approximately 2.5 miles above its confluence with the Kootenai River (BURP ID 2001SCDAA045). The sediment load reduction from the current level (Cow Creek is currently at 76% more than background; Deep Creek is currently at 75% above background) toward the goal of 50% more than background is expected to reduce sediment to a load that, although not yet quantified, will fully support beneficial use (cold water aquatic life). Beneficial use support status will be determined using the current assessment method accepted by DEQ at the time the water body is monitored. Monitoring will be completed using BURP protocols. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised to reflect the established supporting sediment yield.

5.1.5.2. Temperature TMDL Compliance Points and Monitoring

Effective shade monitoring can take place on any reach throughout the Deep and Boundary Creek watersheds and compared to estimates of existing shade given in Tables 18 and 19. Those areas with the lowest existing shade estimates should be monitored with solar pathfinders to verify the existing shade levels and to determine progress toward meeting shade targets. Stream segments divided by each change in existing shade level vary in length depending on land use or landscape that has affected shade. It is appropriate to monitor within a given existing shade segment to see if existing shade in that segment has increased toward its target level. Five to ten equally spaced solar pathfinder measurements within a segment should suffice to determine new shade levels in the future.

5.2. Load Capacity

Load capacities for the sediment TMDL are discussed below. Temperature load capacity is discussed in section 5.3.2.

5.2.1. Sediment TMDL Load Capacity

The load capacity for a TMDL designed to address a sediment-caused limitation to water quality is complicated by the fact that the state's water quality standard is a narrative rather than a quantitative standard. In the waters of Cow and Deep Creeks, the sediment interfering with the beneficial use (cold water) is most likely large bed load material. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to develop.

The natural background sedimentation rate is the sediment yield prior to anthropogenic influences in the watershed. It was calculated by multiplying the Cow Creek (13,528 acres) and Deep Creek (116,760 acres) watershed acreages by the sediment yield coefficient for a mixed geologic setting. The sediment yield rate is an average of granitic and belt supergroup terrain vegetated by coniferous forests. The sediment yield coefficient for granitic geologies is 0.036 tons/acre/year (t/a/y) and the sediment yield coefficient for belt supergroup terrain is 0.023 t/a/y. The estimate assumes the entire watershed was vegetated by coniferous forest prior to development. As shown in Table 14, the estimated natural background value for the entire Cow Creek watershed is 405 tons per year and for Deep Creek it is 3,491 tons per year (Table 15). Thus, the 50% above background sediment yield goals equal 608 and 5,237 tons per year, respectively.

Table 14. Cow Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Cow Creek BURP ID 1995SCDA B041	13,528	713	405	608	Model

[1]Beneficial Use Reconnaissance Program

Table 15. Deep Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Deep Creek BURP ID 2001SCDA A045	116,760	6,122	3,491	5,237	Model

[1]Beneficial Use Reconnaissance Program

The load capacity was developed by calculating background sedimentation based on acreage above the point of compliance, then adding an additional 50% to the value. The goal is an estimated goal that will be replaced by the final sediment goal when the criteria for full support of cold water use are met.

5.2.1.1. Seasonality and Critical Conditions Affecting Sediment Load Capacity

Sediment from nonpoint sources is not delivered to streams seasonally. It is delivered episodically, primarily during high discharge events. These critical events coincide with the critical conditions and typically occur during November through May. However, such events may not occur for several years. The return time of the largest events is usually 10-15 years (DEQ 2001).

Critical conditions are part of the analysis of load capacity. The beneficial uses in this subbasin are impaired due to chronic sediment conditions. Due to the chronic condition, this TMDL deals with yearly sediment loads. The concept of critical conditions is difficult to reconcile with the impact caused by sediment. The critical condition concept assumes that under certain conditions, chronic pollution problems become acute pollution problems. Therefore, it is important to ensure that acute conditions do not occur. The proposed sediment reductions in the TMDL will reduce the chronic sediment load and will also reduce the likelihood that an acute sediment loading condition will exist. It is in this way that critical conditions are accounted for in the TMDL.

5.2.2. Temperature TMDL Load Capacity

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade target levels specified for the reaches within that stream. These loads are determined by multiplying the solar load to a flat plat collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e., the percent open, which is equal to 1.0 minus the shade percentage). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% of the load hitting the flat plate collector under full sun.

DEQ obtained solar load data for flat plate collectors from two nearby National Renewable Energy Laboratory (NREL) weather stations. The two closest stations are in Kalispell, Montana and Spokane, Washington. Because the Kootenai Valley is located between these two stations, an average of values from the two stations was calculated. The solar loads used in this TMDL are spring/summer averages, thus, DEQ uses an average load for the six month period from April through September. These months coincide with the time of year that stream temperatures are increasing and deciduous vegetation is in leaf. Tables 18 and 19 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m2/day and kWh/day) that serve as the loading capacities for the streams.

For Boundary Creek, DEQ has used the same red cedar/hemlock community PNV shade target (60%) for the entire reach (Table 18). Fore Deep Creek, DEQ has used the mixed deciduous trees and shrubs PNB target (60% and 72%) for all but the last 1.5 miles of stream. The bottomland of Deep Creek has the cottonwood gallery PNV shade target (30%)

5.3. Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads. Existing load estimates are discussed separately for the sediment TMDL and the temperature TMDL.

5.3.1. Sediment TMDL Estimates of Existing Pollutant Loads

Point sources of sediment do not exist in the Cow and Deep Creek watersheds. Nonpoint sources of sediment yield were estimated in Section 5.1.4.1. Loading rates were based on land use type. The estimated sediment loads from the watershed above the points of compliance were shown in Table 14 and Table 15.

Historic burn areas in Cow Creek, and residential development and stream bank erosion in Deep Creek are the largest sources of sediment in the watershed. The percentage of sediment delivery estimated according to the number of acres in each land use type, based on land ownership, is provided in Table 16 for Cow Creek and Table 17 for Deep Creek.

Table 16. Current loads from nonpoint sources in Cow Creek.

Land Use Type	Location	Load tons/year	Estimation Method
Roads	Cow Creek watershed	5	Model
Shrub/Historic Burn	Cow Creek watershed	485	Model
Acres at background coefficient	Cow Creek watershed	223	Model
Disturbed	Cow Creek watershed	negligible	Model
Total	-	713	-

Table 17. Current loads from nonpoint sources in Deep Creek.

Land Type	Location	Load tons/year	Estimation Method
Roads	Deep Creek watershed	122	Model
Acres at background coefficient	Deep Creek watershed	3,154	Model
Valley Agriculture	Deep Creek watershed	na	Model

Bench Agriculture	Deep Creek watershed	391	Model
Stream bank erosion	Deep Creek watershed	2,242	Model
Disturbed	Deep Creek watershed	95	Model
Pipeline	Deep Creek watershed	98	Model
Railroad	Deep Creek watershed	20	Model
Total	-	6,122	-

5.3.2. Temperature TMDL Estimates of Existing Pollutant Loads

Regulations all that loadings "…may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting allotments, depending on the availability of data and appropriate techniques for predicting the loading., (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated base on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in non-point loads.

Existing loads used in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presenting in figures 26 and 27 for Boundary Creek and Deep Creek, respectively.

Existing shade varied little over the entire reach of Boundary Creek in Idaho (Figure 26 and Table 18). Solar pathfinder data (average summer shade 'April through September' = 62.7%) taken in a section of boundary Creek that was estimated to have 60% shade verified the accuracy of the aerial photo interpretation. Existing shade estimates on Deep Creek, from aerial photo interpretation varied from a low of 10% to target levels (30%, 60%, or 72%,) (Figure 27 and Table 19). Solar pathfinder data used to verify aerial photo interpretation estimates on Deep Creek were initially taken at the mouth, where shade estimates were the lowest. In that reach, average summer shade (April through September) was measured as 5.5%, compared to the aerial photo estimate of 10%. More solar pathfinder measurements were taken later at additional points. All the points where solar pathfinder measurements were taken on Deep Creek are shown on Figure 28.

Table 18. Existing and Potential Solar Loads for Boundary Creek.

Segment Length (~miles)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)
6	0.6[a]	2.2	0.6	2.2	0.0
0.8	0.5	2.8	0.6	2.2	-0.6
0.3	0.6[b,c]	2.2	0.6	2.2	0.0
0.3	0.4	3.3	0.6	2.2	-1.1
Average	**0.5**	**2.6**	**0.6**	**2.2**	**-0.4**
Segment Length (meters)	Segment area (m^2)	Existing Summer Load (kWh/day)		Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)

9656	222088	488593.6		488593.6	0
1287	29601	81402.75		65122.2	-16280.55
483	11109	24439.8		24439.8	0
483	11109	36659.7		24439.8	-12219.9
Total		**631096**		**602595**	**-28500**

a - pathfinder field measurement of 52.3%
b - verified with solar pathfinder
c - field measured shade = 62.7%.

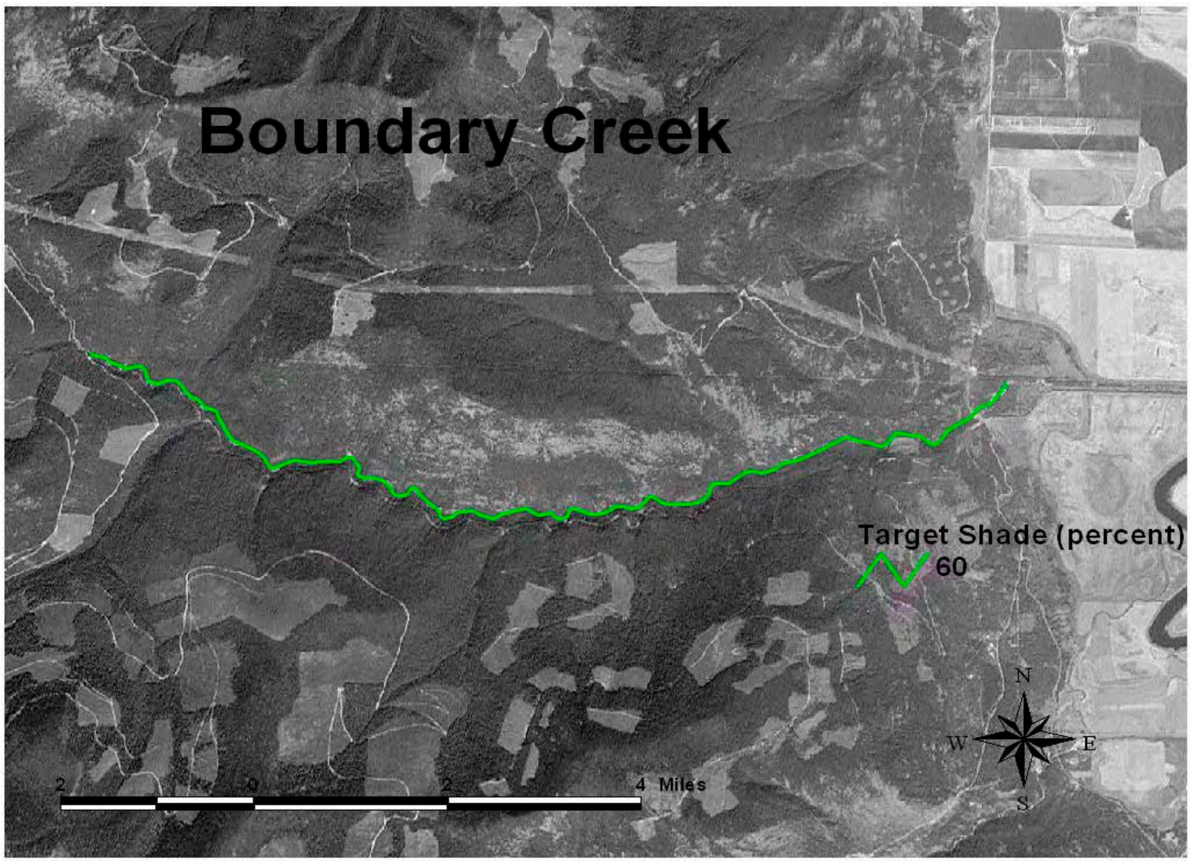

Figure 24. Target Shade for Boundary Creek.

Table 19. Existing and Potential Solar Loads for Deep Creek.

Segment Length (~miles)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Target or Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	
1.3 (start from lake)	0.6	2.2	0.72	1.54	-0.7	Mixed Deciduous Tree & Shrub
1	0.5	2.8	0.72	1.54	-1.2	10 meters wide
1.5	0.6	2.2	0.72	1.54	-0.7	
1	0.5	2.8	0.72	1.54	-1.2	
0.6	0.2	4.4	0.72	1.54	-2.9	
0.5	0.7	1.7	0.72	1.54	-0.1	
0.5	0.5	2.8	0.72	1.54	-1.2	
0.2	0.4	3.3	0.72	1.54	-1.8	
0.3	0.2	4.4	0.72	1.54	-2.9	
0.5	0.4	3.3	0.72	1.54	-1.8	
1.2	0.3	3.9	0.72	1.54	-2.3	
0.5	0.5	2.8	0.72	1.54	-1.2	
0.7	0.3	3.9	0.72	1.54	-2.3	
4.7	0.2	4.4	0.6	2.2	-2.2	20 meters wide
1.5	0.1*	5.0	0.3	3.85	-1.1	Cottonwood Gallery Forest (60m wide)
Average	**0.4**	**3.3**	**0.7**	**1.7**	**-1.6**	

*verified with solar pathfinder, field measured shade = 5.5%.

Segment Length (meters)	Segment Area (m^2)	Existing Summer Load (kWh/day)		Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)
2092	20920	46024		32216.8	-13807.2
1609	16090	44247.5		24778.6	-19468.9
2414	24140	53108		37175.6	-15932.4
1609	16090	44247.5		24778.6	-19468.9
966	9660	42504		14876.4	-27627.6
805	8050	13282.5		12397	-885.5
805	8050	22137.5		12397	-9740.5
322	3220	10626		4958.8	-5667.2
483	4830	21252		7438.2	-13813.8
805	8050	26565		12397	-14168
1931	19310	74343.5		29737.4	-44606.1
805	8050	22137.5		12397	-9740.5
1127	11270	43389.5		17355.8	-26033.7
7564	151280	665632		332816	-332816
2414	144840	716958		557634	-159324
Total		**1846455**		**1133354**	**-713101**

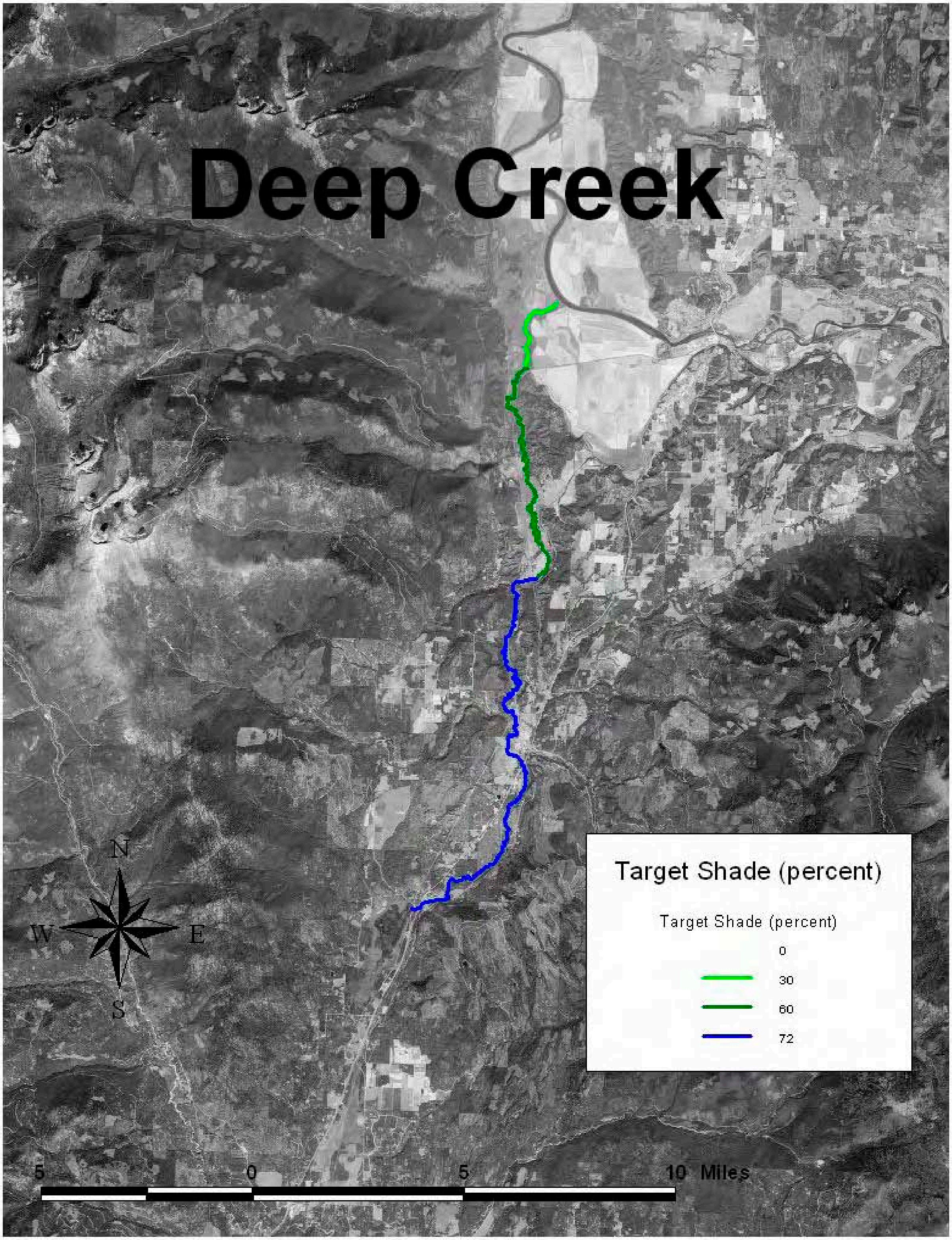

Figure 25. Target Shade for Deep Creek.

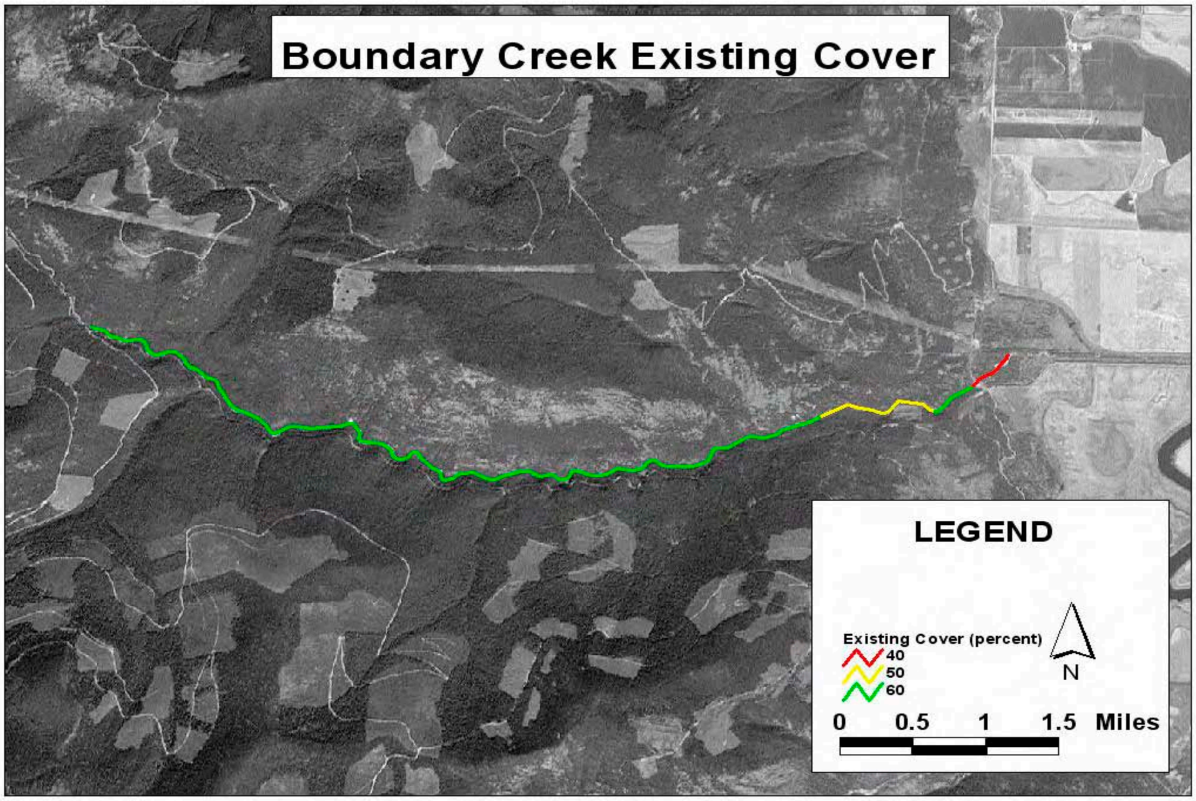

Figure 26. Existing Shade for Boundary Creek Estimated by Aerial Photo Interpretation.

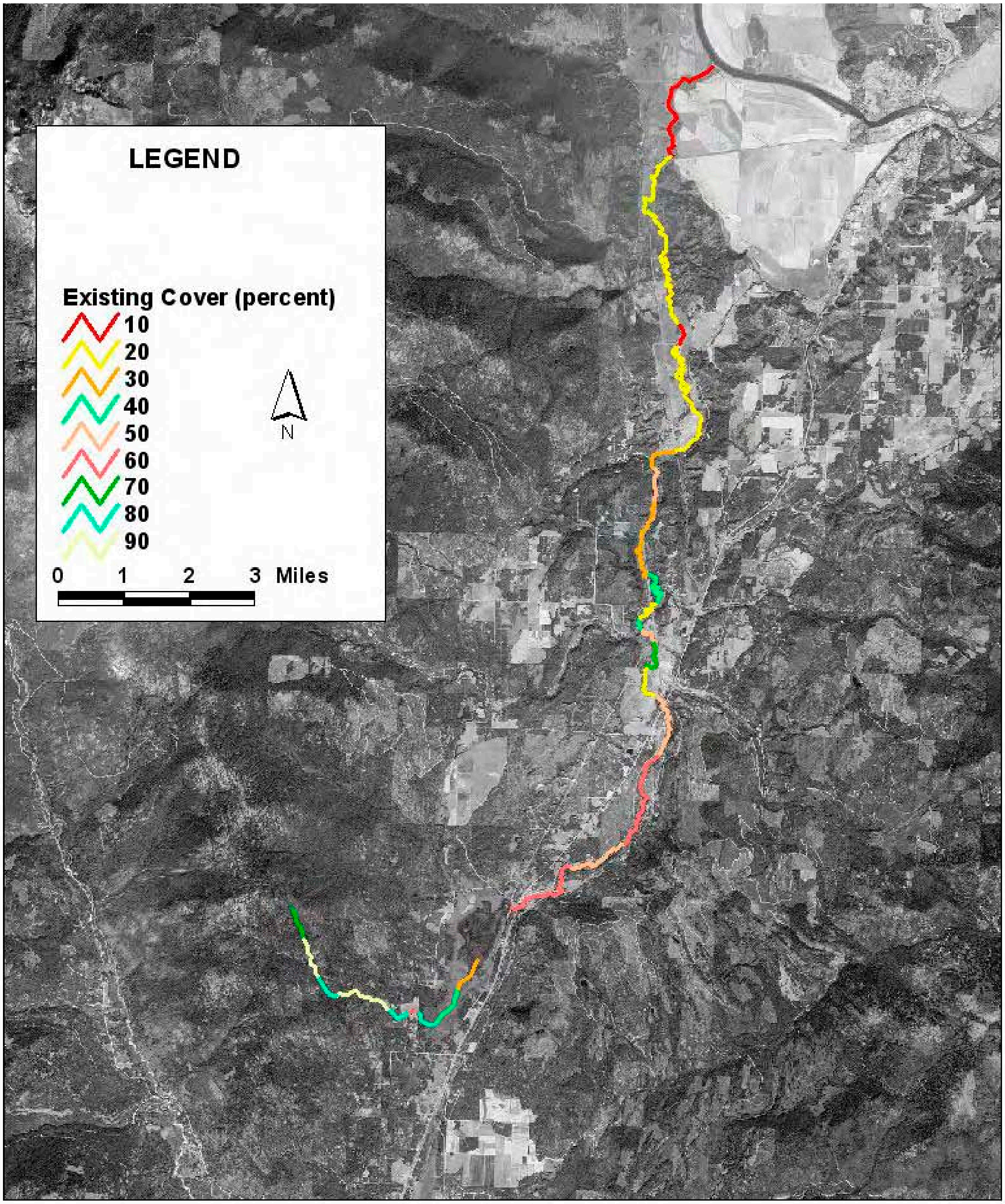

Figure 27. Existing Shade for Deep Creek Estimated by Aerial Photo Interpretation.

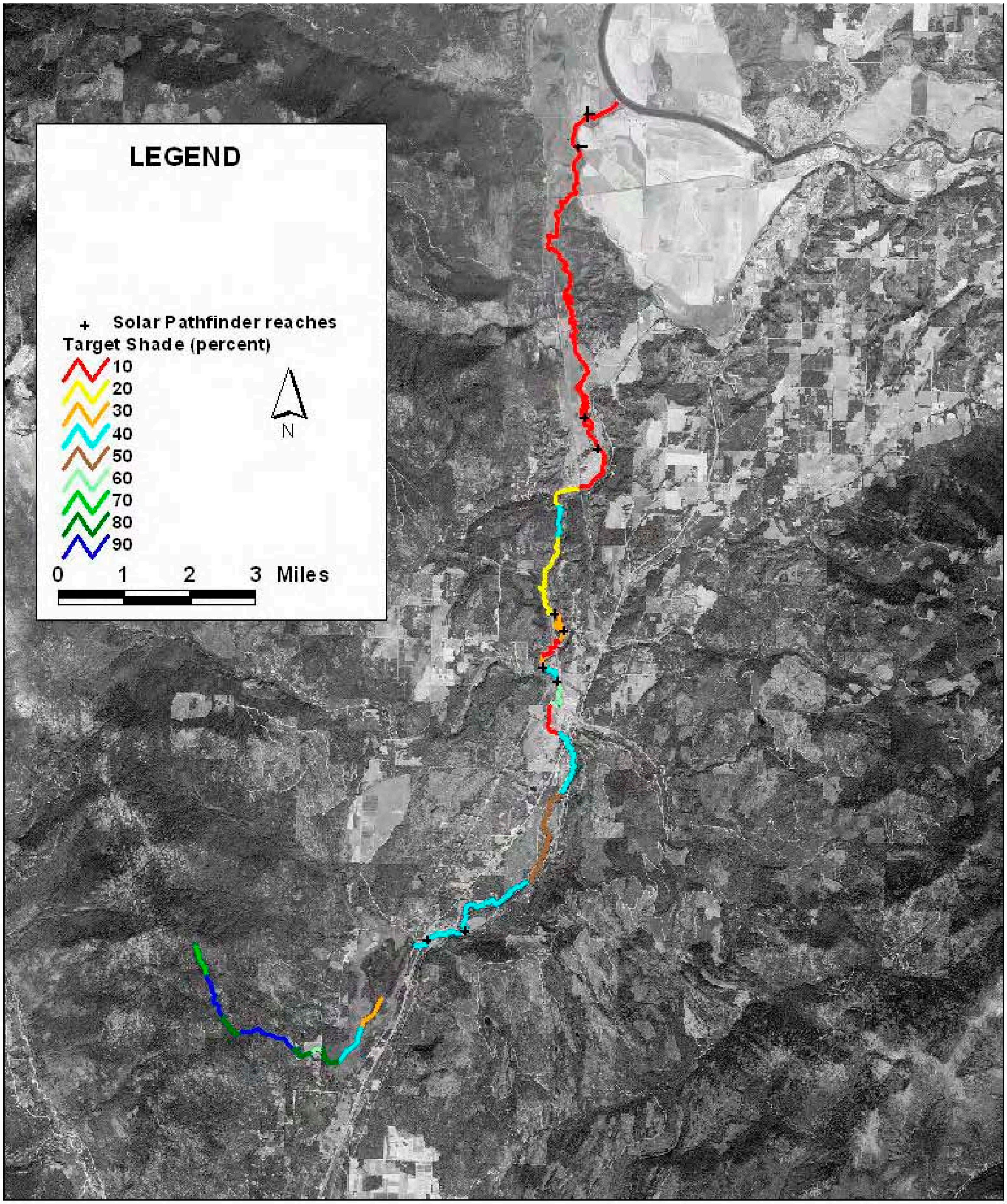

Figure 28. Existing Shade for Deep Creek Measured With Solar Pathfinder.

5.4. Load Allocation

Load allocations are discussed separately for the sediment TMDL and the temperature TMDL.

5.4.1. Sediment TMDL Load Allocation

The pollutant allocation is the load capacity minus the margin of safety and the background. A pollutant allocation is comprised of the WLA of point sources and the load allocation of nonpoint sources. Since there are no point sources, this sediment TMDL has a load allocation only.

The load allocations and reductions are shown in Table 20 for Cow Creek and Table 21 for Deep Creek. The allocations are based on the modeled estimate of nonpoint source sediment contribution of 713 tons per year (Cow Creek), 6,122 tons per year (Deep Creek) and a reduction to 50% above background. The allocation includes the background sediment yield of 405 and 3,491 tons per year, respectively, and the margin of safety is applied at the point of compliance. The load reduction required for each land ownership type is based on the difference between the existing sediment contribution and the load capacity at 50% above background. After implementation, 30 years have been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

Table 20. Sediment load allocations and load reductions required for land owners along Cow Creek.

Owner/Manager	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
U.S. Forest Service	688	100	30 years
Private	2	negligible	-
State	23	4	30 years
Total	713	104	-

Table 21. Sediment load allocations and load reductions required for land owners along Deep Creek.

Owner/Manager	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Bureau of Land Management	42	4	30 years
U.S. Forest Service	1,741	209	30 years
Private	3,219	534	30 years
State of Idaho	1,051	126	30 years
State of Idaho Fish and Game	53	9	30 years
National Wildlife Refuge	16	3	30 years
Total	6,122	885	-

5.4.1.1. Detailed Breakdowns of Sediment Load Allocations

A list of the sediment yield coefficients used is given first, then load allocations for Cow Creek and Deep Creek are discussed. Following that, there is a discussion about developing sediment load allocations from disturbed landscape.

5.4.1.1.1. Sediment yield coefficients used in the Kootenai River Subbasin sediment TMDL.

Bench Agriculture 0.055 (t/a/y)
Valley Agriculture 0.026 (t/a/y)
Forest (natural background) 0.03 (t/a/y)
  0.03 (t/a/y) is an average of Meta sediment and Granitic geologies
    Meta sediment geology 0.023 (t/a/y)
    Granitic geology 0.036 (t/a/y)
Forest Road 0.50 (t/a/y)
  Average of CWE scores form within the basin.
Railroad 0.50 (t/a/y)
Pipeline 25 (t/a/y)
  Developed from data supplied by Gas Transmission Northwest
Disturbed 0.07 (t/a/y)
Access road associated with
  disturbed landscape 2 (t/a/y)
  Developed from Boundary County stream bank erosion survey data.
Burn/Shrub 0.08 (t/a/y)

5.4.1.1.2. Cow Creek load allocations and details

The following tables first give the load allocations assigned by land use type for Cow Creek. Allocations are then applied according to land managers and owners based on land use.

Table 22. Cow Creek load allocation as assigned by land use type.

Land use	**Total Acres in Watershed** (values obtained from GIS coverage)	**Current sediment generation (t/y)** (total land use acres x sediment coefficient)	**Load contribution by land use** (current sediment generation by land use/(current sediment generation total-acres at background coefficient)	**Reduction required for land use (t/y)** (total reduction required x load contribution by land use)
Acres at Background Coefficient	7,408	222	na*	na*
Forest road	10	5	1%	1
Disturbed	1	negligible	negligible	negligible
Burn	6,069	486	99%	103
Open	40	0	0	0
Total	*13,528*	*713*	*100%*	*104*

*Development reduction allocation not applicable due to modeling difficulties. See section X.

Table 23. Land use within privately owned lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	78	na*	2	na*
Disturbed	1	negligible	negligible	negligible
Total	79	0.6%	2	negligible

*Reductions not allocated to acres at background coefficient.

Table 24. Land use within Idaho Department of Lands managed lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	162	na*	5	na*
Burn	221	4%	18	4
Total	383	3%	23	4

*Reductions not allocated to acres at background coefficient.

Table 25. Land use within United States Forest Service managed lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	7,168	na*	215	na*
Forest Road	10	100%	5	1
Burn	5,848	96%	468	99
Open	40	na	0	na
Total	13,066	96.4%	688	100

*Reductions not allocated to acres at background coefficient.

The following tables identify current loads from nonpoint government managed sources and from nonpoint privately managed sources in the Cow Creek watershed.

Table 26. Current loads from nonpoint Federal and State government managed sources in the Cow Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Acres at Background Coefficient	na*	na*
Forest Road	1	100%
Burn	103	100%
Total	104	na

*Reductions not allocated to acres at background coefficient.

Table 27. Current loads from nonpoint privately owned sources in the Cow Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Acres at Background Coefficient	na*	na*
Low Density Development	negligible	negligible
Total	negligible	negligible

*Reductions not allocated to acres at background coefficient.

5.4.1.1.3. Deep Creek load allocations and details

The following tables first give the load allocations assigned by land use type for Deep Creek. Allocations are then applied according to land managers and owners based on land use.

Table 28. Deep Creek load allocation as assigned by land use type.

Land use type	Total Watershed Acres (acres) (values obtained from GIS coverage)	Current sediment generation (t/y) (area x sediment coefficient)	Load contribution by land use (current sediment generation by land use/(current sediment generation total-acres at background coefficient)	Reduction required for land use (t/y) (total reduction required x load contribution by land use)
Bench Agriculture	7,105	391	13%	115
Valley Agriculture*	3,026	na*	na*	na*
Acres at Background Coefficient	105,145	3,154	na**	na**
Forest road	245	122	4%	35
Disturbed	756	95	3%	27
Railroad	41	20	1%	9
Pipeline	4	98	3%	27
Stream bank erosion	59	2,242	76%***	672
Open	379	0	0	0
Total	*116,760*	*6,122*	*100%*	*885*

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 29. Land use within BLM administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	946	na*	28	na*
Stream bank erosion	na**	0.6%	14	4
Total	946	0.8%	42	4

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 30. Land use within NWR administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Valley Agriculture	328	na*	na*	na*
Acres at Background Coefficient	242	na**	7	na**
Forest road	1	negligible	negligible	negligible
Railroad	1	1.3%	negligible	negligible
Stream bank erosion	na***	0.4%	9	3
Open	18	na	0	na
Total	590	0.4%	16	3

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 31. Land use within privately owned lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	6,967	98%	383	113
Valley Agriculture	2,627	na*	na*	na*
Acres at Background Coefficient	47,538	na**	1,426	na**
Forest road	161	65.7%	80	23
Disturbed	756	100%	95	27
Railroad	36	87.8%	18	8
Pipeline	4	100%	94	27
Stream bank erosion	na***	50%	1,123	336
Open	9	na	0	na
Total	58,098	49.8%	3,219	534

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 32. Land use within Idaho Department of Lands administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	14	0.2%	1	negligible
Valley Agriculture	72	na*	na*	na*
Acres at Background Coefficient	20,814	na**	625	na**
Forest road	37	15%	19	5
Railroad	4	10.6%	2	1
Stream bank erosion	na***	18%	404	120
Total	20,941	18%	1,051	126

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 33. Land use within Idaho Department of Fish and Game administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	112	1.6%	6	2
Forest road	3	1%	1	negligible
Acres at Background Coefficient	802	na*	24	na*
Railroad	<1	0.3%	negligible	negligible
Stream bank erosion	na**	1%	22	7
Open	329	na	0	na
Total	1,249	1%	53	9

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 34. Land use within United States Forest Service administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	12	0.2%	1	negligible
Acres at Background Coefficient	34,803	na*	1,044	na*
Forest road	44	17.9%	22	7
Stream bank erosion	na**	30%	674	202
Open	23	na	0	na
Total	34,882	30%	1,741	209

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

The following tables identify current loads from nonpoint government managed sources and from nonpoint privately managed sources in the Deep Creek watershed.

Table 35. Current sediment loads from nonpoint Federal and State government managed sources in the Deep Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Bench Agriculture	2	2%
Valley Agriculture	na*	na*
Acres at Background Coefficient	na**	na**
Forest Road	12	34.3%
Railroad	1	12.2%
Stream bank erosion	336	50%
Total	351	na

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.

Table 36. Current sediment loads from nonpoint privately owned sources in the Deep Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Bench Agriculture	113	98%
Valley Agriculture	na*	na*
Acres at Background Coefficient	na**	na**
Forest Road	23	65.7%
Railroad	8	87.8%
Disturbed	27	100%
Pipeline	27	100%
Stream bank erosion	336	50%
Total	534	na

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.

5.4.1.2. Developing Sediment Load Allocations From Disturbed Landscape

5.4.1.2.1. Discussion

Uncertainties were evident in the initial processes used to determine the spatial extent of rural development in the Kootenai River Subbasin sediment TMDL. In order to address these issues and reach the target load capacity set in the TMDL, a disconnect from the sediment model was needed.

Sediment yield allocated to high and low density development was modeled to be contributing approximately 50% of the total modeled sediment generation. Previously high and low density development sediment reductions were not allocated to land managers because of modeling limitations. Not requiring land managers to reduce the modeled sediment generation from high and low density development would result in failure to meet the target load capacity set in the TMDL.

Sediment contribution from high and low density development to surface waters is noted as occurring within the basin. However, the modeled amount of sediment yield to surface water is uncertain. Estimates of sediment contribution have the potential of ranging from thousands of pounds per year to hundreds of pounds per year. The problem is known to exist but limited information reduces the precision to which an estimation can be made.

The initial high and low density development strategy discussed in the previous section does not appear appropriate for load allocations. Approximately half of the load generated in the watershed was constructed from acreages and loading coefficients that had been estimated and did not result from scientifically derived data or processes. While the initial estimates seemed to be reasonable when separate, the compounding of the estimates resulted in less than reasonable results.

The sediment modeling process discussed above was applied to BURP sites in the Lower Kootenai River Subbasin. Land use types were modeled within the basin to determine an appropriate target. A target of 50% above background was established using this method. In the initial model, high and low density development land use type was applied throughout the basin to achieve the target. This process identified streams which exhibit failing WBAG II scores and modeled high sediment yields.

To reach reasonable results a second step was taken to allocate sediment generated from high and low density development, now called disturbed landscape. The disturbed land use type was developed from known structures within the Deep Creek watershed. Based on professional experience within the watershed, each structure was assumed to disturb one acre of land and occupy a 20-acre lot. Using a road width of 20 feet and length of 640 feet, the average access road is 0.03 acres in size. A sediment yield coefficient of 0.07 t/a/y was applied to the one acre disturbed by a structure and 2 t/a/y was applied to the access road. The sediment yield of 0.07 t/a/y was derived from best professional judgment and an estimate which assumes a structure disturbance would generate slightly more than twice background sediment. A poorly maintained forest road within the basin would typically generate 2 t/a/y. The estimated road sediment generation was derived from field observations, data collected in the basin and professional experience.

A disturbed landscape is defined in the model as the land associated with known structures within the basin. This process of allocating a sediment load to rural and urban areas is an attempt to capture all known land use types within the basin. Future attempts to model a disturbed landscape should not be done until a better understanding of sediment yield from such landscapes is understood. Additional information should be a priority within the basin to refine sediment coefficients in order to determine the most appropriate sediment load allocation.

5.4.1.2.2. <u>Conclusion</u>

Attempts to model sediment yield to surface water are intended to provide relative, rather than exact, sediment yields. The Lower Kootenai and Moyie River Subbasins sediment model attempts to model all land use types observed in the watershed separately. Attempting to model different sediment sources observed in the watershed is intended to identify the primary sources of sediment. Identifying sediment sources will be useful when developing implementation strategies designed to retard sediment delivery to surface water.

Data gaps exist in the Lower Kootenai and Moyie River Subbasins sediment model and are not expected to be filled in the near future. Future sediment modeling of disturbed landscape in the basin may consider adjusting the neighborhood area or adjusting the sediment yield coefficient accordingly. These adjustments to the model may better represent sediment yield to surface water and achievable load allocations. Modeling of sediment yield to surface waters of the basin is intended to highlight areas of the basin which are main sediment contributors.

5.4.2. Temperature TMDL Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade. Load allocations are therefore specific to each stream reach and are dependent upon the target load for a given reach.

and 1 show the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1 minus the shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to allocate shade removal to an activity.

Generally, existing solar loads exceed potential solar loads on Deep Creek, and to a lesser extent on Boundary Creek, because existing shade is less than potential shade. Deep Creek's existing solar load is 2,027,916 kWh/day and its target load should be 1,133,354 kW/day. The difference (-894,562 kWh/day) shows that loads on Deep Creek need to decrease by about 44% to achieve background conditions. Boundary Creek's potential summer load should be about 600,000 kWh/day to maintain temperatures at background conditions. Existing summer load exceeds that value by 28,500 kWh/day, requiring about 4.5% reduction in load to achieve background conditions.

In addition to not having load allocations for nonpoint source activities, there are also no point sources in the affected watersheds. Thus, there are no wasteload allocations. Should a point source be proposed that would have thermal consequence on these waters, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

5.4.3. Margin of Safety

5.4.3.1. Sediment TMDL Margin of Safety

The margin of safety is implicit in the model used. Loading capacities set at 50% above background have been used in previous TMDLs and considered sufficiently conservative. This level of conservative assumptions provides an over-estimation of sediment yield. The over-estimation is the implicit margin of safety. Given the conservatively high estimations developed by the model, no additional explicit margin of safety is deemed necessary. An implicit margin of safety of 231% for Belt Supergroup geologies and 164% for Kaniksu Granitics was averaged and applied in the sediment model.

5.4.3.2. Temperature TMDL Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, there are no loads allocated to sources or activities. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance.

5.4.4. Seasonal Variation

5.4.4.1. Sediment TMDL Seasonal Variation

The method used for calculation of sediment pollutant load in this TMDL does not account for seasonal variation. Instead the load is described in the units of percent above background.

5.4.4.2. Temperature TMDL Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning (see Figures C-1 through C-10 in Appendix C). Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.4.5. Reasonable Assurance

5.4.5.1. Sediment TMDL Reasonable Assurance

The model identified stream bank erosion within the watershed as the primary source of sediment. The federal government manages 97% of the land in the Cow Creek watershed, the State of Idaho manages 3% and less than 1% is privately owned. In the Deep Creek watershed the federal government manages 30%, the State of Idaho 18%, State of Idaho Fish and Game 1%, the Bureau of Land Management less than 1% and private individuals 50%. The large federal ownership within the subbasin should assure implementation plan development and execution. Sediment issues on private land can be addressed by incentives provided to private land owners by the Boundary Soil and Water Conservation District. The plan will be implemented based primarily on the budgetary constraints of incentive programs and federal agencies.

5.4.5.2. Temperature TMDL Reasonable Assurance

Reasonable assurance is provided by nonpoint source implementation of BMPs based on land management agencies' assurance that reductions will occur. Incentive programs offered to privately owned and managed land will also help to insure solar load reductions.

5.4.6. Background Load

5.4.6.1. Sediment TMDL Background Load

The background sediment load for the Cow Creek watershed is 405 tons per year and 3,491 tons per year for the Deep Creek watershed, as shown in

Table 14 and Table 15, respectively. The background is treated as part of the load capacity and is allocated as part of the load capacity. Any unknown unallocated point sources would be included in the background portion of the allocation.

5.4.6.2. Temperature TMDL Background Load

The background temperatures and thermal inputs to Deep and Boundary Creek are unknown. It is assumed that when stream shading reaches PNV targets that background temperatures and thermal inputs will be achieved.

5.4.7. Load Reserve

5.4.7.1. Sediment TMDL Load Reserve

No part of the load allocation is held for additional load. All new infrastructures should be constructed or mitigated to allow no net increase in sediment yield to the Deep and Cow Creek watersheds.

5.4.7.2. Temperature TMDL Load Reserve

Reserve is typically removed from a WLA for installations that might be made in the future. No WLA or reserve is developed for the temperature TMDL. The thermal capacity of the watershed has been exceeded by canopy removal. Canopy restoration to the degree possible is required to address the thermal loading. Point sources of thermal input cannot be permitted for the foreseeable future.

5.4.8. Construction Storm Water and TMDL Wasteload Allocations

5.4.8.1. Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a nonpoint source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

5.4.8.2. The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

5.4.8.3. Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain the best management practices (BMPs) through the life of the project.

5.4.8.4. Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ now incorporates a gross wasteload allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

5.5. Implementation Strategies

DEQ and designated management agencies (DMA) responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the designated management agencies will continue to evaluate suspect sources of impairment and develop management actions appropriate to deal with these issues.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

5.5.1. Time Frame

For sediment TMDLs, 30 years has been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

A reasonable time frame should be allotted for meeting target shade levels in the Boundary and Deep Creek watersheds. A substantial time frame may be needed to reach PNV after implementation strategies have been installed.

5.5.2. Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the subbasin. The designated WAG, DMAs and other appropriate public process participants, are expected to:

- Develop best management practices (BMPs) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analyses of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, with reference to costs and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct 5-year reviews of progress toward TMDL goals.

5.5.3. Responsible Parties

In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

5.5.4. Monitoring Strategy

Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling.

5.6. Conclusions

5.6.1. Sediment TMDL Conclusions

The assessment of the Lower Kootenai River Subbasin indicates that WBAG II scores and sediment modeling reveal sediment impairment of the cold water use in Cow Creek and Deep Creek. A sediment TMDL has been prepared for Cow Creek and Deep Creek. The TMDL sets a goal of 50% above natural background sediment yield based on sediment yield from watersheds of the subbasin fully supporting the cold water beneficial use. A load capacity was set based on this goal. An implicit margin of safety of 231% for Belt Supergroup geologies and 164% for Kaniksu Granitics was averaged and applied in the sediment model. No point sources of sediment exist or are expected. Sediment load allocations were allocated to land managers and owners based on the amount of land managed or owned and modeled land use types within the watershed.

The remaining available load is allocated among the nonpoint sources (load allocation), since no point sources of sediment exist or are expected to exist in the watersheds.

5.6.2. Temperature TMDL Conclusions

Target shade levels for Boundary and Deep Creek were determined from effective shade curves from other northwest TMDLs with similar vegetation characteristics and stream widths. Existing shade levels were estimated from aerial photos and field verified with a solar pathfinder.

Existing shade levels on Boundary Creek are only slightly less than target shade levels. Calculations indicate a 4.5% reduction in solar loading is needed to achieve natural background levels. However, this level of reduction is probably within the variability of the estimation techniques used to generate loads. Boundary Creek is likely at its potential in terms of shading and solar loading. It is not known what conditions exist in Canada upstream on Boundary Creek. Temperatures vary about 2 ^{o}C from the upper end of Boundary Creek to the lower end in Idaho (Figures C-2 and C-3), a 1,600-foot change in elevation. It is likely that this temperature difference is the result of elevation changes in air temperature.

Because existing shade is less than potential shade solar loads exceed potential solar loads on Deep Creek. Existing shade levels within Deep Creek were modeled to be 44% above background conditions. Calculations indicate a 44% reduction in solar loading is needed to achieve natural background levels.

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GIS Coverages

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Glossary

§305(b)
Refers to section 305 subsection "b" of the Clean Water Act. The term "305(b)" generally describes a report of each state's water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§303(d)
Refers to section 303 subsection "d" of the Clean Water Act. Subsection 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

Acre-foot
A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.

Adsorption
The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules

Aeration
A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic
Describes life, processes, or conditions that require the presence of oxygen.

Adfluvial
Describes fish whose life history involves seasonal migration from lakes to streams for spawning.

Adjunct
In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin

A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.

Algae

Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Alluvium

Unconsolidated recent stream deposition.

Ambient

General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).

Anadromous

Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the saltwater but return to fresh water to spawn.

Anaerobic

Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.

Anoxia

The condition of oxygen absence or deficiency.

Anthropogenic

Relating to, or resulting from, the influence of human beings on nature.

Anti-Degradation

Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic
Occurring, growing, or living in water.

Aquifer
An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

Assemblage (aquatic)
An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

Assessment Database (ADB)
The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.

Assessment Unit (AU)
A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Assimilative Capacity
The ability to process or dissipate pollutants without ill effect to beneficial uses.

Autotrophic
An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.

Batholith
A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.

Bedload
Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

Beneficial Use

Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers

Benthic

Pertaining to or living on or in the bottom sediments of a water body

Benthic Organic Matter.

The organic matter on the bottom of a water body.

Benthos

Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Best Professional Judgment

A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.

Biochemical Oxygen Demand (BOD)

The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biomass

The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.

Biota

The animal and plant life of a given region.

Biotic

A term applied to the living components of an area.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.

Coliform Bacteria

A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. Coli*, and Pathogens).

Colluvium

Material transported to a site by gravity.

Community

A group of interacting organisms living together in a given place.

Conductivity

The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/centimeter at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.

Cretaceous

The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.

Criteria

In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Cultural Eutrophication

The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).

Culturally Induced Erosion

Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).

Debris Torrent

The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition

The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).

Designated Uses

Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Discharge

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO)

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
Disturbed landscape	A portion of landscape that has been disturbed by human caused urbanization activities, including but not limited to impacts by structures like houses, barns, and out buildings, and the road network that supports these structures. This term is used in the loading allocations and results from initial low and high density development estimates for target establishment.
E. coli	Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecological Indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.
Ecological Integrity	The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving water body.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for

	declaring a species as endangered are contained in the Endangered Species Act.
Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Existing Beneficial Use or Existing Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
Exotic Species	A species that is not native (indigenous) to a region.

Extrapolation

Estimation of unknown values by extending or projecting from known values.

Fauna

Animal life, especially the animals characteristic of a region, period, or special environment.

Fecal Coliform Bacteria

Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, *E. coli*, and Pathogens).

Fecal Streptococci

A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.

Feedback Loop

In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.

Fixed-Location Monitoring

Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow

See *Discharge*.

Fluvial

In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.

Focal

Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

Fully Supporting but Threatened

An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a "not fully supporting" status.

Geographical Information Systems (GIS)

A georeferenced database.

Geometric Mean

A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

Grab Sample

A single sample collected at a particular time and place. It may represent the composition of the water in that water column.

Gradient

The slope of the land, water, or streambed surface.

Ground Water

Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Growth Rate

A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

High Density Development

A category of land use established for the development of sediment TMDL targets. This category results from a GIS exercise where buildings were used as an indicator of urbanization, and related impacts. High density areas were roughly those areas where there was more than one building every 20 acres. High density developments include Bonner's Ferry and other town sites.

Hydrologic Basin

The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle

The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.

Hydrologic Unit

One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Impervious

Describes a surface, such as pavement, that water cannot penetrate.

Influent

A tributary stream.

Inorganic

Materials not derived from biological sources.

Instantaneous

A condition or measurement at a moment (instant) in time.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Interstate Waters

Waters that flow across or form part of state or international boundaries, including boundaries with Native American nations.

Irrigation Return Flow

Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Key Watershed

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.

Knickpoint

Any interruption or break of slope.

Land Application

A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.

Limiting Factor

A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology

The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Load(ing) Capacity (LC)	A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Lotic	An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Low Density Development	A category of land use established for the development of sediment TMDL targets. This category results from a GIS exercise where buildings were used as an indicator of urbanization, and related impacts. Low density areas were roughly those areas where there was less than one building every 20 acres.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.
Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mass Wasting

A general term for the down slope movement of soil and rock material under the direct influence of gravity.

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Median

The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11.

Metric

1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Milligrams per Liter (mg/L)

A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).

Million Gallons per Day (MGD)

A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.

Miocene

Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.

Monitoring

A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth

The location where flowing water enters into a larger water body.

National Pollution Discharge Elimination System (NPDES)

A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nitrogen

An element essential to plant growth, and thus is considered a nutrient.

Nodal

Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.

Nonpoint Source

A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

Not Attainable

A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Not Fully Supporting Cold Water

At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.

Nuisance

Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient

Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Nutrient Cycling

The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).

Oligotrophic

The Greek term for "poorly nourished." This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.

Organic Matter

Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate

A form of soluble inorganic phosphorus most readily used for algal growth.

Oxygen-Demanding Materials

Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.

Parameter

A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

Partitioning

The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.

Pathogens

A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Perennial Stream

A stream that flows year-around in most years.

Periphyton

Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.

Pesticide

Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

pH

The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Phased TMDL

A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Physiochemical

In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the term “physical/chemical.”

Plankton	Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality

	control; and personnel qualifications and training (Rand 1995). The goal of QA is to assure the data provided are of the quality needed and claimed (EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples (Rand 1995). QC is implemented at the field or bench level (EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.
Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Reference Site	A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.
Representative Sample	A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.
Resident	A term that describes fish that do not migrate.

Respiration

A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

Riffle

A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian

Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

Riparian Habitat Conservation Area (RHCA)

A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:

- 300 feet from perennial fish-bearing streams
- 150 feet from perennial non-fish-bearing streams
- 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.

River

A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.

Runoff

The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

Sediments

Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Settleable Solids

The volume of material that settles out of one liter of water in one hour.

Species

1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.

Spring

Ground water seeping out of the earth where the water table intersects the ground surface.

Stagnation
The absence of mixing in a water body.

Stenothermal
Unable to tolerate a wide temperature range.

Stratification
A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).

Stream
A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.

Stream Order
Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.

Storm Water Runoff
Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.

Stressors
Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subbasin
A large watershed of several hundred thousand acres. This is the name commonly given to 4^{th} field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)
A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed
A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6^{th} field hydrologic units.

Surface Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Taxon

Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).

Tertiary

An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.

Thalweg

The center of a stream's current, where most of the water flows.

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary

A stream feeding into a larger stream or lake.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

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Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Vadose Zone

The unsaturated region from the soil surface to the ground water table.

Wasteload Allocation (WLA)

The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution

Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality

A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria

Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited

A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Limited Segment (WQLS)

Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

Water Quality Management Plan

A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water Quality Modeling

The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.

Water Quality Standards

State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Table

The upper surface of ground water; below this point, the soil is saturated with water.

Watershed

1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller

"subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.

Water Body Identification Number (WBID)

A number that uniquely identifies a water body in Idaho and ties in to the Idaho water quality standards and GIS information.

Wetland

An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Young of the Year

Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

Table A-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (cfs)[a]	Cubic Meters per Second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31cfs	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

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Appendix B. State and Site-Specific Standards and Criteria

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al. 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

> 13^{o}C as a daily maximum water temperature,
>
> 9^{o}C as a daily average water temperature.

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of highest annual MWMT air temperatures) is compared to the daily maximum criterion of 13^{o}C. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during these time periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply. As per IDAPA 58.01.02.200.09:

> *When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.*

Section 401 relates to point source wastewater treatment requirements. In this case if temperature criteria for any aquatic life use is exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3^{o}C (IDAPA 58.01.02.401.03.a.v.).

Estimate of Bankfull Channel Width

The only factor not developed from the aerial photo work presented above is channel width (i.e., NSDZ or Bankfull Width). Accordingly, this parameter must be estimated from available information. Leopold et. al (1964) proposed that channel width tends to increase linearly with increases in drainage area. Rosgen (1996) reported that bankfull width can be estimated as a function of width to depth ratio and cross-sectional area. For this calculation, the following equation is used:

$$BFW = \sqrt{W:D \cdot A_{bf}}$$

Where: A_{bf} is the Bankfull Cross-Sectional Area (ft^2)
W:D is the width to depth ratio

Figure B-1 illustrates the regional curve for bankfull cross-sectional area (A_{bf}) and drainage area (DA) in the Upper Salmon River Basin (USGS Professional Paper 870-A). Deep Creek was divided into several sections. GIS was used to calculate the upstream contributing area (DA) at the lower end of each of these sections. Upstream contributing areas between these locations were estimated through interpolation. Bankfull Cross-Sectional Area was then estimated using the relationship presented in Figure B-1. Width to depth ratio values were assigned values derived from published ranges for level I stream types (Rosgen 1996). Target Bankfull Width values for each of these Rosgen Level I Stream Types were estimated using the equation listed above (Figure B-2). Target values developed during this exercise were used to develop channel width conditions used in Effective Shade Calculations.

Level I Stream Type	Width to Depth (W:D)
A	8
B	19
C	30
D	N/A
E	7
F	28
G	8

Figure B-1. Bankfull Cross-Sectional Area as a function of Drainage Area in the Upper Salmon River Basin, Idaho (Emmett 1975)

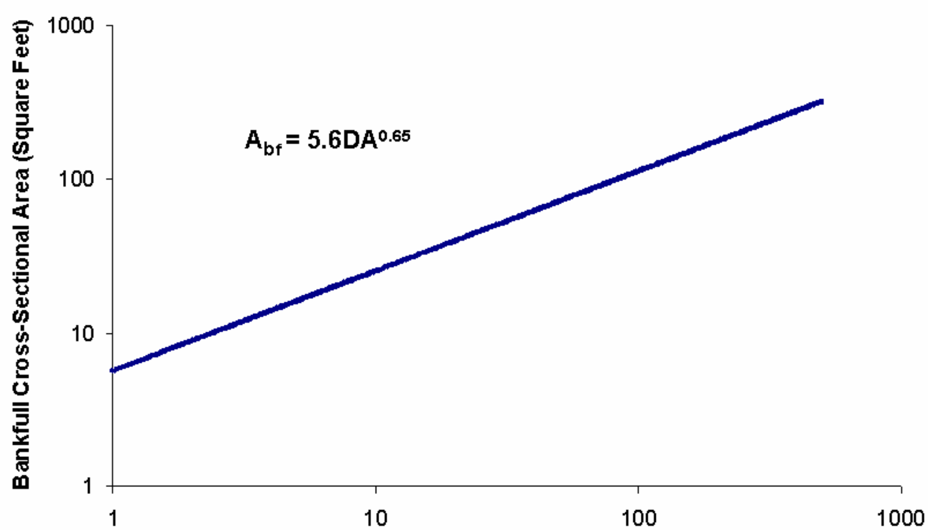
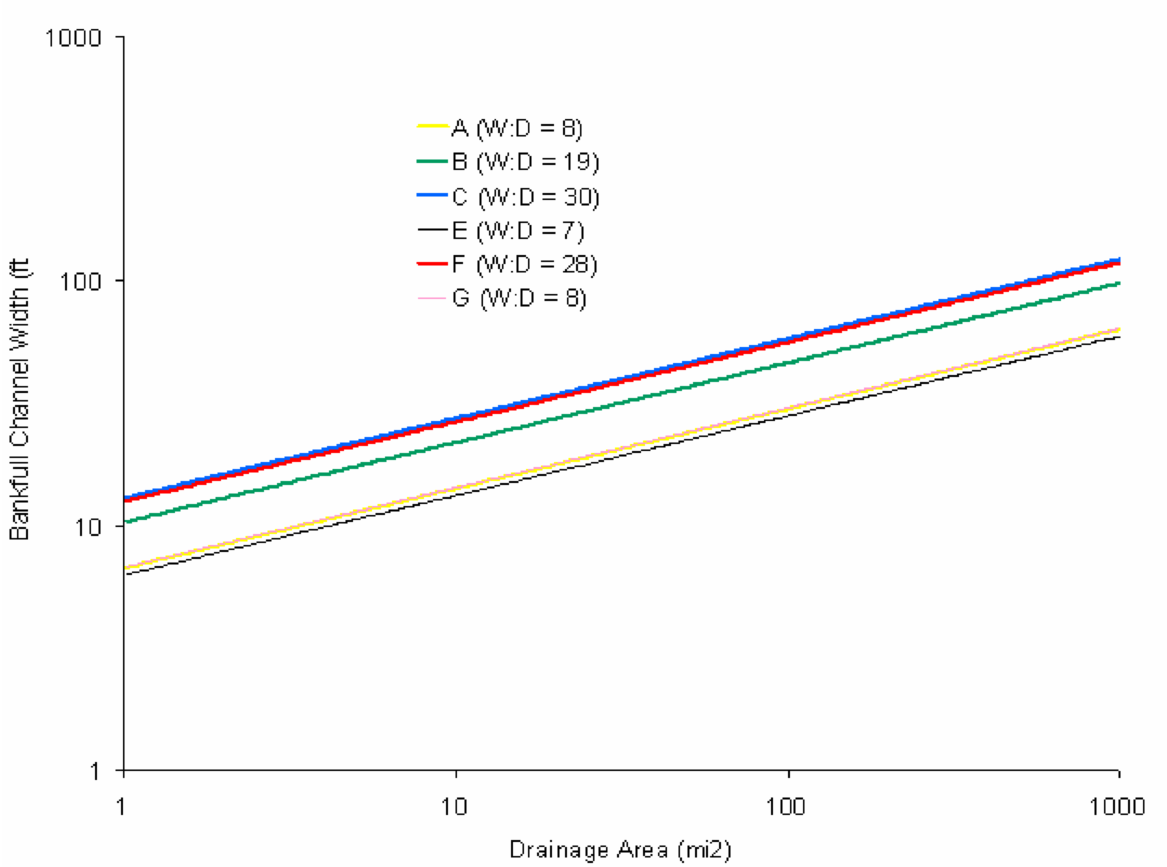


Figure B-2. Bankfull Width as a Function of Width to Depth Ratio and Drainage Area



Accordingly, Rosgen level I classification can be used to estimate approximate bankfull width conditions through applying the equation listed above (Figure B-2). The Rosgen level I classification for Deep Creek were estimated to be Class C. The drainage area for Deep Creek is roughly 181 mi^2 with 129 mi^2 above Brown Creek. Deep Creek natural stream widths below Brown Creek (Rosgen C type) were likely in the neighborhood of 20m (66ft) as determined from Figure B-2. The drainage area for McArthur Lake and Deep Creek above Trail Creek is about 41 mi^2. Therefore, natural stream widths from McArthur Lake to Brown Creek (Rosgen B & C types) were determined to be about 10m (33ft).

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Appendix C. Data Sources

Table C-1. Data sources for Lower Kootenai and Moyie River Subbasin Assessment.

Water Body	Data Source	Type of Data	When Collected
Boundary Creek and Deep Creek	DEQ Coeur d'Alene Regional Office	Pathfinder effective shade and stream width	March 2005
Boundary Creek and Deep Creek	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	February-March 2005
Boundary Creek and Deep Creek	DEQ IDASA Database	Temperature	1998-2001

Table C-2. Temperature loggers deployed in the Lower Kootenai and Moyie River Subbasins between 1998 and 2001.

Site ID	Stream	Dates deployed
1998SCDATL0001	Boundary Creek	07/30/1998-10/21/1998
1998SCDATL0002	Boundary Creek	07/30/1998-10/21/1998
1998SCDATL0003	Grass Creek	07/31/1998-10/19/1998
1998SCDATL0004	Grass Creek	07/30/1998-10/21/1998
1998SCDATL0005	Blue Joe Creek	07/30/1998-10/21/1998
1998SCDATL0006	Skin Creek	06/20/1998-09/23/1998
1998SCDATL0007	Deer Creek	06/20/1998-10/21/1998
1998SCDATL0008	Deer Creek	06/20/1998-10/21/1998
1998SCDATL0009	Deer Creek	06/20/1998-10/21/1998
1998SCDATL0010	Meadow Creek	06/20/1998-10/21/1998
2000SCDATL0001	Ball Creek	06/23/2000-10/01/2000
2000SCDATL0003	Blue Joe Creek	06/22/2000-10/17/2000
2000SCDATL0004	Boulder Creek	05/25/2000-10/04/2000
2000SCDATL0005	Boundary Creek	05/26/2000-10/03/2000
2000SCDATL0006	Brown Creek	05/25/2000-10/02/2000
2000SCDATL0007	Caribou Creek	05/23/2000-10/02/2000
2000SCDATL0008	Cascade Creek	05/23/2000-10/02/2000
2000SCDATL0009	Cow Creek	05/26/2000-10/03/2000
2000SCDATL0010	Curley Creek	05/27/2000-10/04/2000
2000SCDATL0011	Dodge Creek	05/23/2000-10/02/2000
2000SCDATL0012	Fall Creek	05/23/2000-06/14/2000
2000SCDATL0013	Fisher Creek	06/23/2000-10/03/2000
2000SCDATL0014	Fleming Creek	05/24/2000-10/04/2000
2000SCDATL0015	Gillion Creek	05/24/2000-10/04/2000
2000SCDATL0016	Grass Creek	06/23/2000-09/17/2000
2000SCDATL0017	Long Canyon Creek	07/21/2000-08/27/2000
2000SCDATL0018	Long Canyon Creek	06/23/2000-10/03/2000
2000SCDATL0020	Miller Creek	05/24/2000-10/04/2000
2000SCDATL0021	Mission Creek	05/24/2000-10/04/2000
2000SCDATL0022	Parker Creek	06/23/2000-10/03/2000
2000SCDATL0023	Parker Creek	07/21/2000-08/27/2000
2000SCDATL0024	Rock Creek	05/24/2000-10/04/2000

2000SCDATL0025	Skin Creek	05/27/2000-10/04/2000
2000SCDATL0026	Smith Creek	06/23/2000-10/03/2000
2000SCDATL0027	Smith Creek	05/26/2000-08/03/2000
2000SCDATL0028	Trial Creek	05/23/2000-10/02/2000
2000SCDATL0029	Trout Creek	06/23/2000-10/03/2000
2000SCDATL0030	Twentymile Creek	05/25/2000-10/02/2000
2000SCDATL0032	Boulder Creek	05/25/2000-07/15/2000
2000SCDATL0033	Mission Creek	05/24/2000-10/03/2000
2000SCDATL0034	Myrtle Creek	05/23/2000-10/02/2000
2000SCDATL0035	Round Prairie Creek	05/24/2000-10/04/2000
2000SCDATL0036	Ruby Creek	05/23/2000-10/02/2000
2000SCDATL0037	Snow Creek	05/23/2000-10/02/2000
2000SCDATL0038	Deep Creek	07/20/2000-08/27/2000
2000SCDATL0039	Deep Creek	07/21/2000-08/26/2000
2000SCDATL0040	Deep Creek	07/21/2000-09/12/2000
2000SCDATL0041	Deep Creek	07/21/2000-08/26/2000
2000SCDATL0042	Deep Creek	07/21/2000-09/12/2000
2000SCDATL0043	Deep Creek	07/21/2000-08/26/2000
2000SCDATL0044	Deep Creek	05/25/2000-10/02/2000
2001SCDATL0001	Fisher Creek	07/03/2001-08/12/2001
2001SCDATL0002	Myrtle Creek	07/03/2001-10/10/2001
2001SCDATL0003	Mission Creek	07/04/2001-10/09/2001
2001SCDATL0004	Long Canyon Creek	07/03/2001-10/10/2001
2001SCDATL0005	Boundary Creek	07/03/2001-10/10/2001
2001SCDATL0006	Skin Creek	07/04/2001-10/09/2001
2001SCDATL0008	Brass Creek	07/04/2001-10/09/2001
2001SCDATL0009	Copper Creek	07/04/2001-10/09/2001
2001SCDATL0010	Davis Creek	07/04/2001-10/09/2001
2001SCDATL0011	East Fork Deer Creek	07/04/2001-10/09/2001
2001SCDATL0012	West Fork Deer Creek	07/04/2001-10/09/2001
2001SCDATL0013	Gillion Creek	07/04/2001-10/09/2001
2001SCDATL0016	Upper Meadow Creek	07/02/2001-10/09/2001
2001SCDATL0017	Miller Creek	07/04/2001-10/09/2001
2001SCDATL0018	Placer Creek	07/04/2001-10/09/2001
2001SCDATL0019	Spruce Creek	07/04/2001-10/09/2001
2001SCDATL0022	Canuck Creek	07/07/2001-10/09/2001
2001SCDATL0023	Faro Creek	01/04/2001-10/08/2001
2001SCDATL0025	Trout Creek	07/03/2001-10/10/2001
2001SCDATL0026	Trout Creek	07/03/2001-10/10/2001
2001SCDATL0027	Ball Creek	07/03/2001-08/16/2001
2001SCDATL0029	Parker Creek	07/02/2001-10/10/2001
2001SCDATL0031	Grass Creek	07/03/2001-10/10/2001
2001SCDATL0032	Blue Joe Creek	07/03/2001-10/10/2001
2001SCDATL0033	Keno Creek	07/04/2001-10/09/2001
2001SCDATL0034	Wall Creek	07/02/2001-08/04/2001
2001SCDATL0036	Meadow Creek	07/02/2001-10/09/2001
2001SCDATL0037	Deer Creek	07/04/2001-10/09/2001
2001SCDATL0039	Round Prairie Creek	07/04/2001-10/09/2001

Figure C-1. Boundary Creek Full Season Temperature Data Collected Near USGS Gage (DEQ Logger Site 2000SCDATL0005).

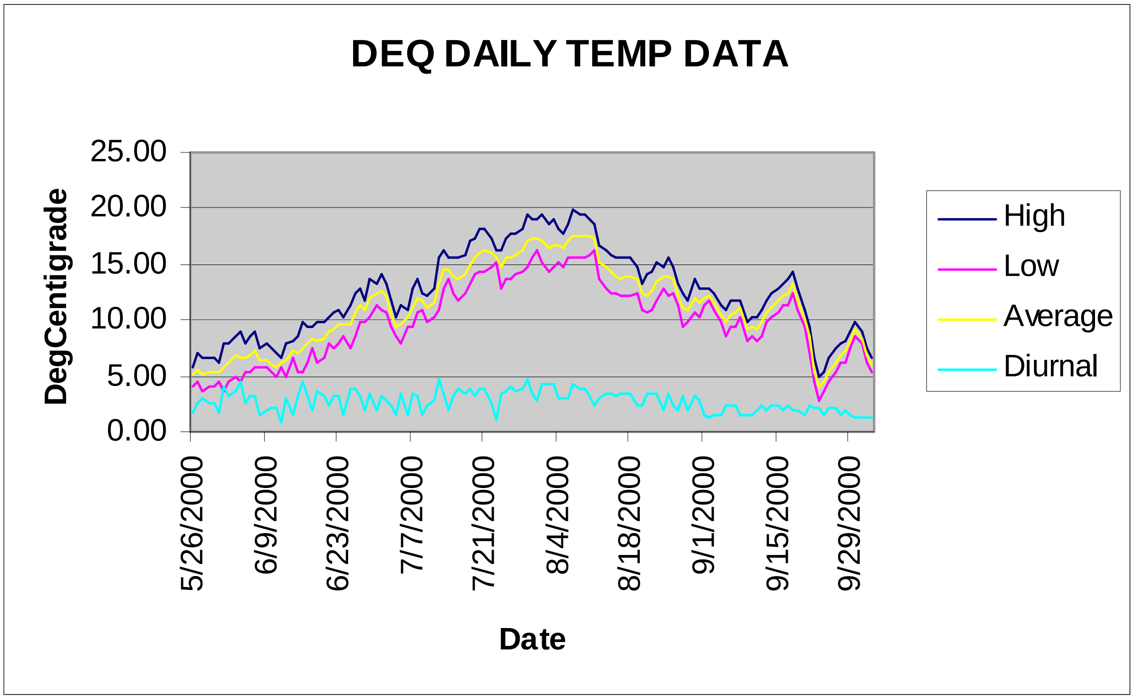


Figure C-2. Upper Boundary Creek Partial Season Temperature Data Recorded at U.S./Canada Border (DEQ Logger Site 1998SCDATL0001).

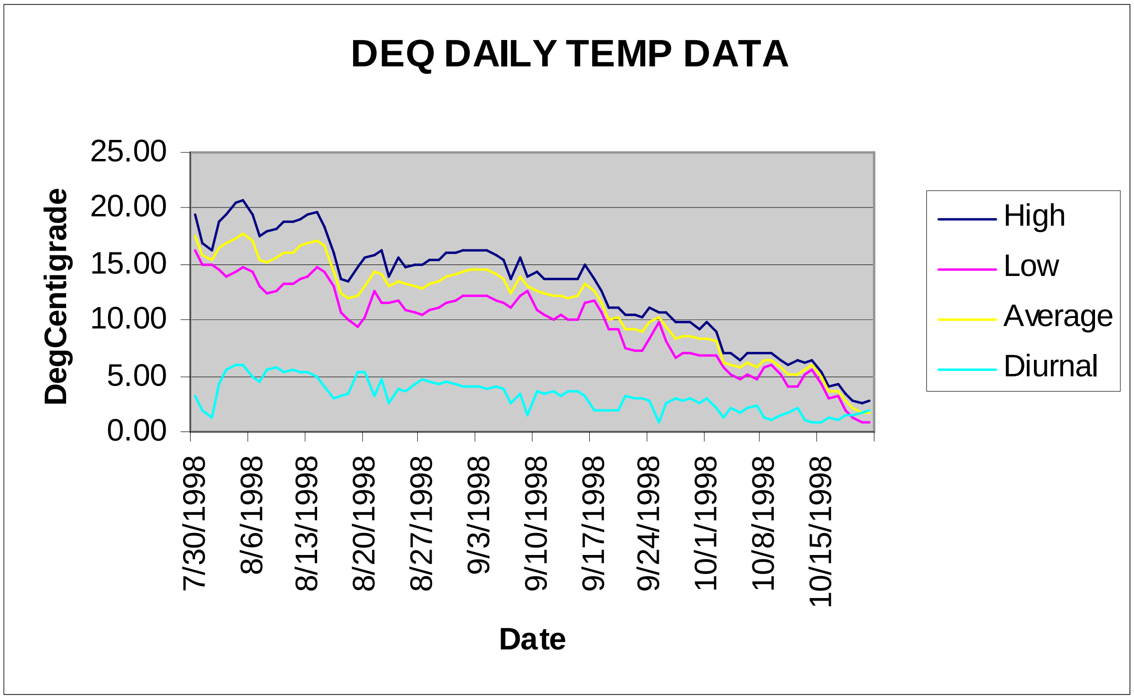


Figure C-3. Boundary Creek Partial Season Temperature Data Recorded Near USGS Gage Station (DEQ Logger Site 1998SCDATL0002).

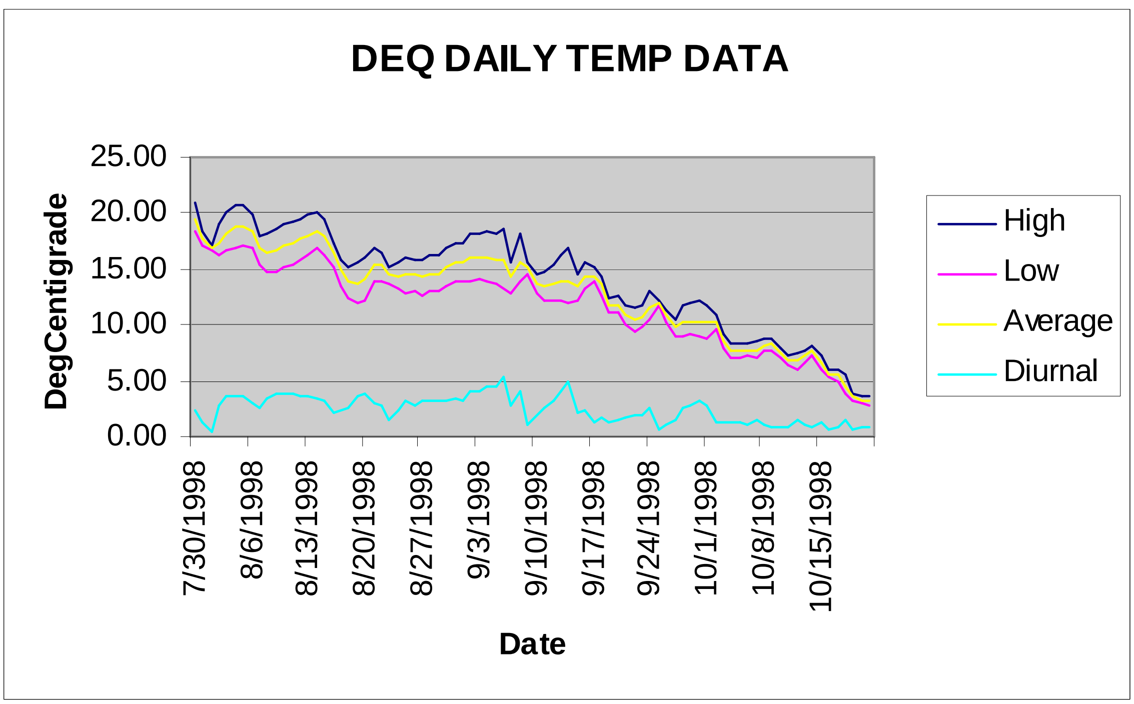


Figure C-4. Boundary Creek Partial Season Temperature Data Recorded Near USGS Gage Station (DEQ Logger Site 2001SCDATL0005).

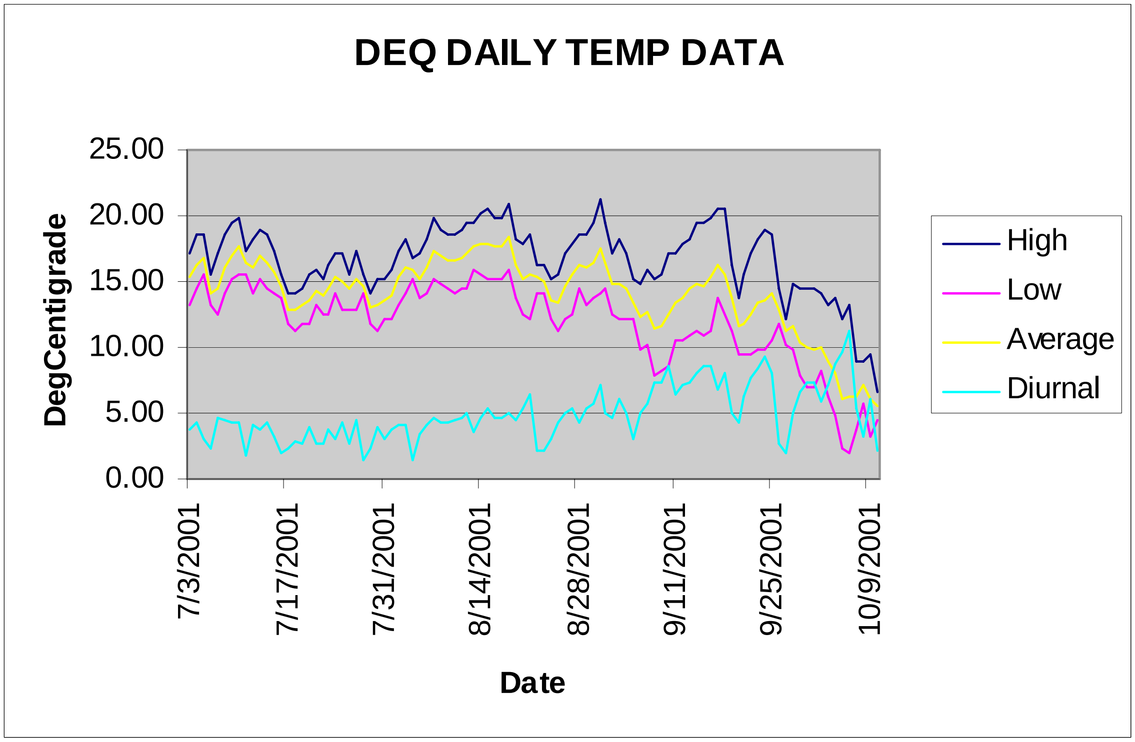


Figure C-5. Deep Creek Full Season Temperature Data Recorded Below Ruby Creek Confluence (DEQ Logger Site 2000SCDATL0044).

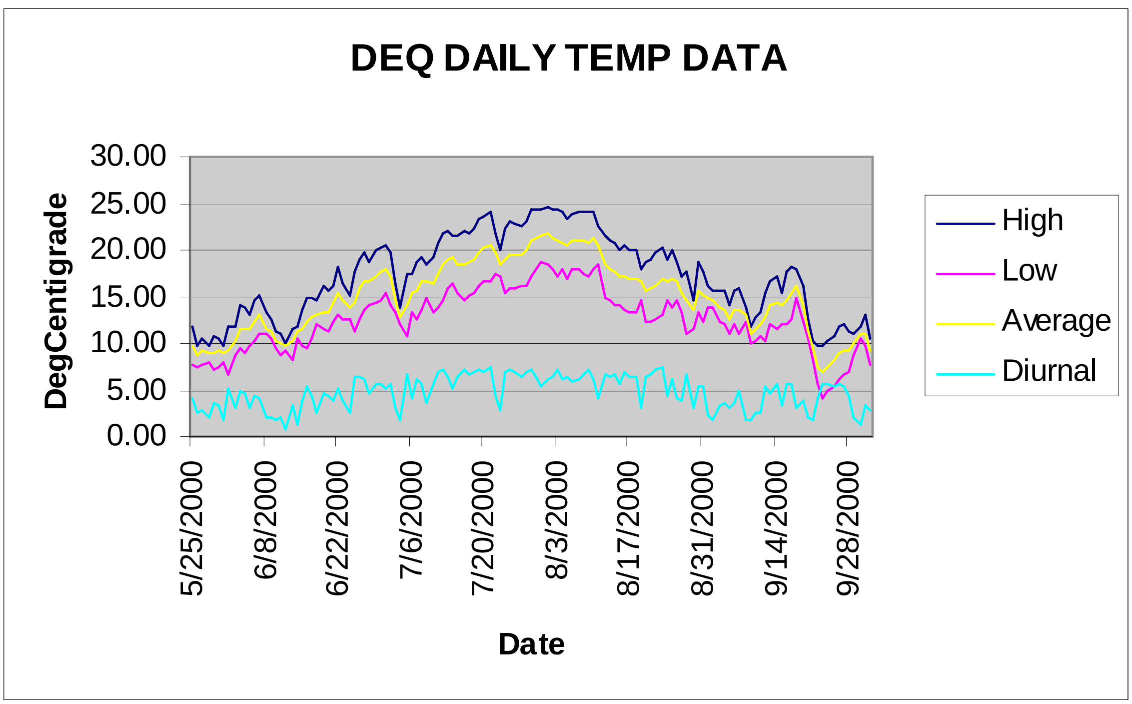


Figure C-6. Deep Creek Partial Season Replicate Series Temperature Data (DEQ Logger Site 2000SCDATL0042).

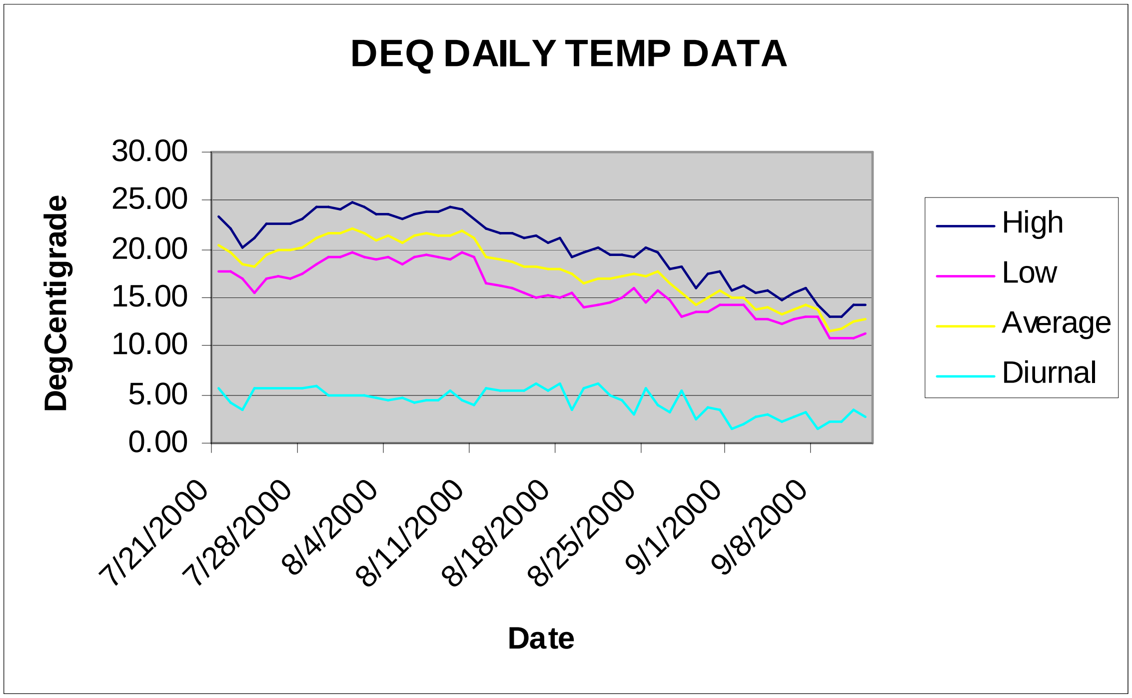


Figure C-7. Deep Creek Partial Season Replicate Series Temperature Data (DEQ Logger Site 2000SCDATL0041).

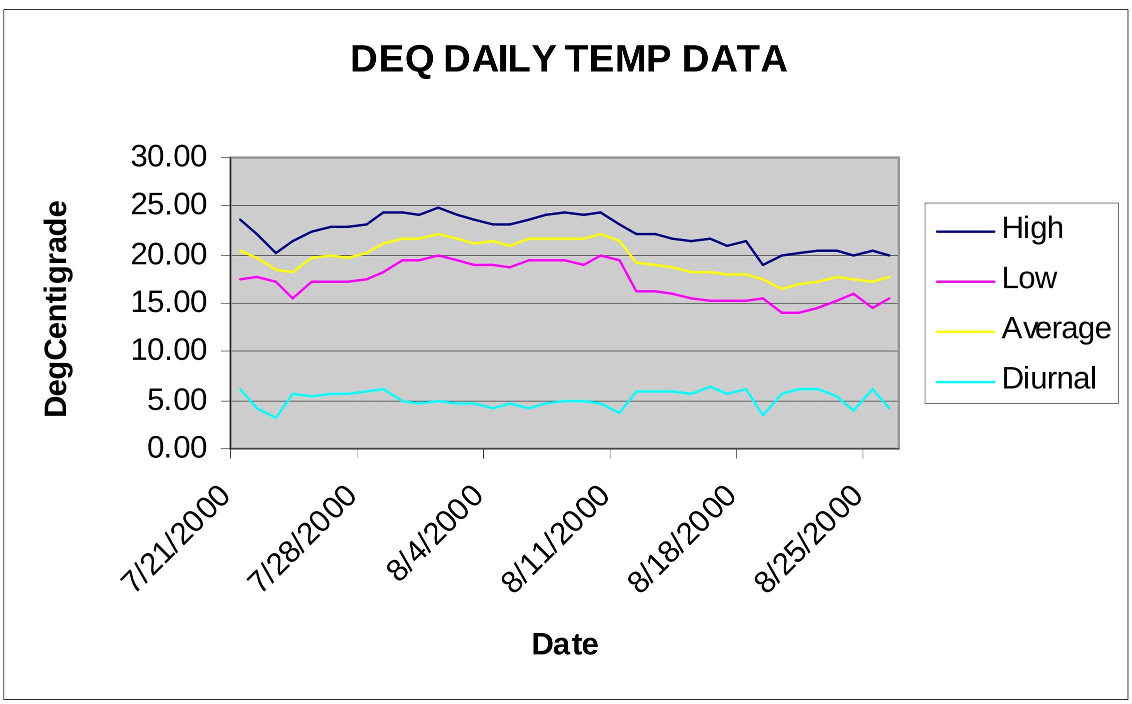


Figure C-8. Deep Creek Partial Season Replicate Series Temperature Data (DEQ Logger Site 2000SCDATL0040).

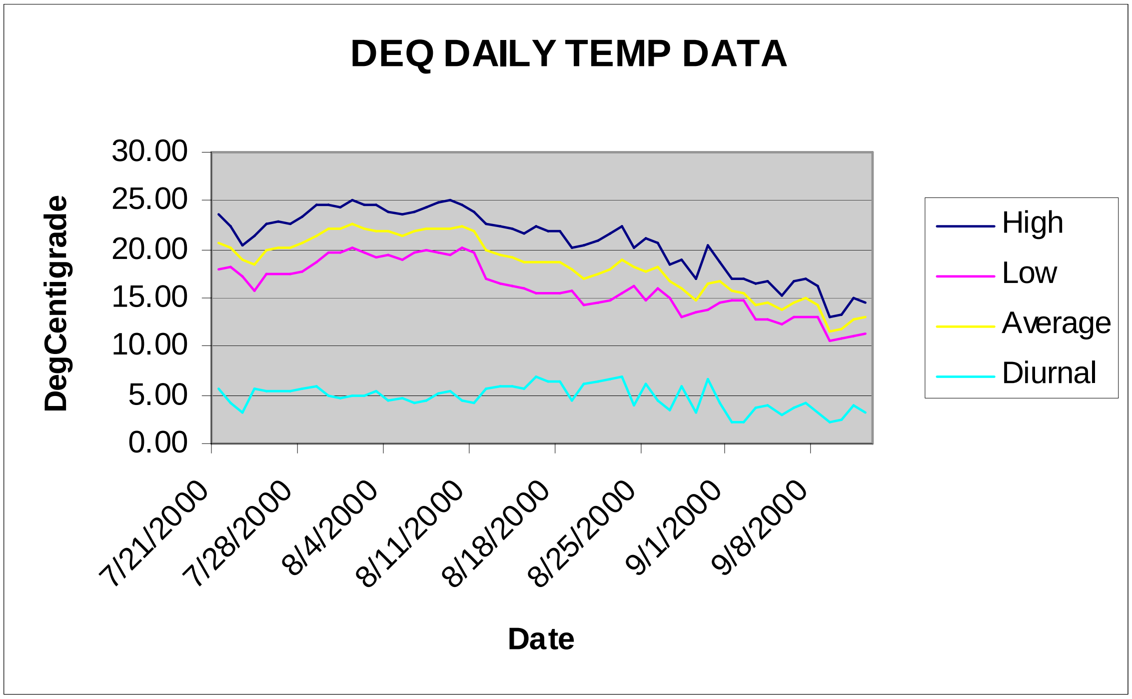


Figure C-9. Deep Creek Partial Season Replicate Series Temperature Data (DEQ Logger Site 2000SCDATL0039).

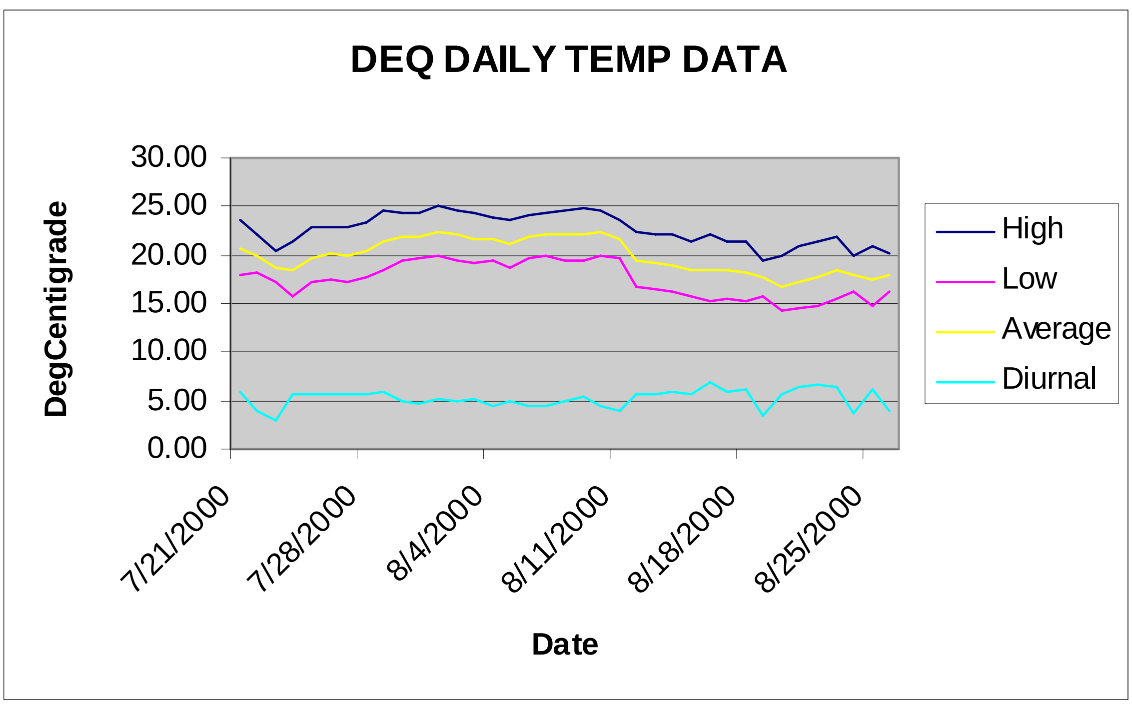
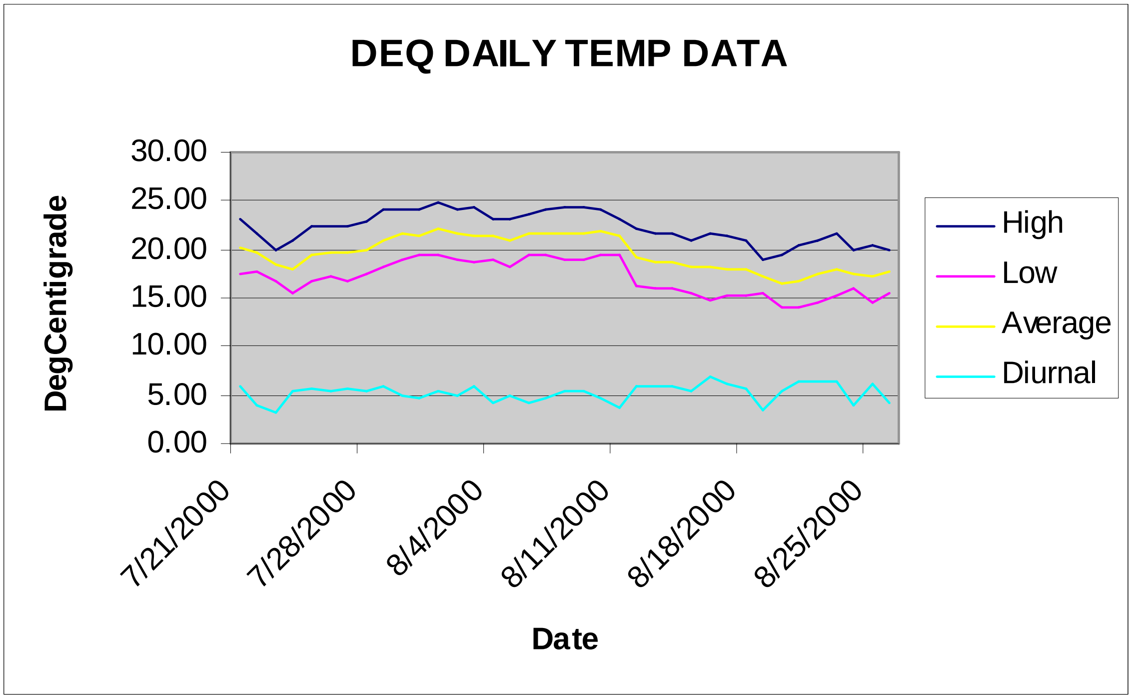


Figure C-10. Deep Creek Partial Season Replicate Series Temperature Data (DEQ Logger Site 2000SCDATL0038).



Appendix D. Distribution List

Appendix E. Public Comments

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Appendix F. Sediment Model Assumptions and Documentation

Background:

In the panhandle region of Idaho, sediment is the pollutant of concern in the majority of water quality limited streams. The lithology, or terrain of the region, most often governs the form the sediment takes. Two major types of terrain dominate in northern Idaho. These are the meta-sedimentary Belt Supergroup and granitics present either in the Kaniksu batholith or in smaller intrusions such as the Round Top Pluton and the Gem Stocks. In some locations Columbia River Basalt formations are important, but these tend to be to the south and west; primarily on the Coeur d'Alene Indian Reservation. Granitics mainly weather to sandy materials, but also weather to pebbles or larger-sized particles. Pebbles and larger particles with significant amounts of sand remain in the higher gradient stream bedload. The Belt terrain produces silt size particles, pebbles, and larger particles. Silt particles are transported to low gradient reaches, while the larger particles comprise the majority of the higher gradient stream bedload. Basalts erode to silt and particles similar in size to the Belt terrain. Large basalt particles are less resistant and weather to smaller particles.

Any attempt to model the sediment output of watersheds will provide relative, rather than exact, sediment yield. The model documented here attempts to account for all significant sources of sediment separately. This approach is used to identify the primary sources of sediment in a watershed. Identification will be useful as implementation plans designed to remedy these sources are developed. If additional investigation indicates that sources quantified as minor are not, the model input can be altered to incorporate this new information.

Model Assumptions:

Land use:

The sediment model attempts to account for all sources of sediment by partitioning these sources into broad categories.

Agriculture

Revised Universal Soil Loss Equation version 2 (RUSLE 2) is the correct model for agricultural land within the basin as it accounts for production and delivery of fine-grained sediment. Two profiles were constructed for the basin to account for the two observed agricultural settings, valley agriculture and bench agriculture. Valley agriculture was delineated as the agricultural land located within the Kootenai River basin valley bottom and maintained for crop production. Areas of bench agriculture are located above the floodplain of the Kootenai River in gently sloping to flat segmented parcels and commonly surround by minor vegetation.

Forest (Natural Background)

Sediment yield coefficients measured in-stream on geologies of north central Idaho cover production and delivery from forested areas. These sediment yield coefficients reflect both fine and coarse sediment.

Forested areas were given the average sediment yield coefficient for metasediment Belt Supergroup and granitic geologies. Forested areas included fully stocked and not fully stocked by Forest Practice Act standards. Applying the sediment yield coefficient to all forested areas provided for a conservative estimate (overestimate).

Stream bank erosion

Erosion from stream bank lateral recession can be estimated with the direct volume method (Erosion and Sediment Yield in Channels Workshop 1983). The volume of sediment was calculated from field measurements and lateral recession rates. Stream bank assessments were made by the Kootenai-Shoshone Soil and Water Conservation District in 2001 and 2002. Stream bank erosion surveys were limited to agricultural areas only.

Forest Roads

Road erosion scores from the Cumulative Watershed Effects (CWE) program was applied to 200 feet of the road on either side of a stream crossing, not tied to total road mileage. Roads which do not cross the stream but are located within 200 feet of the stream were also modeled.

The use of the McGreer relationship between the CWE score and road surface erosion is a valid estimate of road surface fines production and yield. In the case of Belt terrain, it is a conservative estimate (overestimate).

Sediment Delivery:

100% delivery from forestlands with sediment yield coefficients measured in-stream on geologies of north central Idaho.

100% delivery from agriculture lands estimated with RUSLE 2 were applicable.

100% delivery from all road miles up to 200 feet from a stream crossing as estimated by the McGreer relationship.

Fine and coarse materials are delivered at the same rate from fill failures and from erosion resulting from road encroachment and bank erosion.

Model Approach:

Land use is the primary broad category. Land use types are divided into bench and valley agriculture, forest, disturbed, forest roads, stream bank erosion, railroad and pipeline.

Sediment yields from agriculture lands that received any tillage are modeled with RUSLE 2.

Equation 1: A = (R)(K)(LS)(C)(D) tons per acre per year where:

: A is the average annual soil loss from sheet and till erosion
: R is climate erosivity
: K is the soil erodibility
: LS is the slope length and steepness
: C is the cover management
: D is the support practices

The RUSLE 2 does not take into account stream bank erosion, gully erosion, or scour erosion. The RUSLE 2 applies to cropland, pasture, hayland or other land that has some vegetation improvement by tilling or seeding. Based on the soils, the characteristics of the agriculture, and the slope, sediment yields were developed from the agricultural lands of each watershed. The RUSLE 2 develops values that reflect the amount of sediment eroded and delivered to the active channel of the stream system annually.

All coefficients are expressed as tons per acre per year (t/a/y) and are applied to the acreage of each land type developed from the Geographical Information System (GIS) coverage. All land uses are displayed with estimated sediment delivery. Land use sediment delivery is then totaled.

Forest roads were modeled using data developed with the Cumulative Watershed Effects (CWE) protocol. A watershed CWE score was used to estimate surface erosion from the road surface. Forest road sediment yield was estimated using the relationship between the CWE score and the sediment yield per mile of road (Figure F-1). The relationship was developed for roads on a Kaniksu granitic terrain in the LaClerc Creek watershed, figure F-1 (McGreer 1998). Its application to roads on a Belt terrain conservatively estimate sediment yields from these systems. The watershed CWE score was used to develop sediment tons per acre, which was multiplied by the estimated road acreage affecting the stream. It was assumed that all sediment was delivered to the stream system. This is a conservative estimate of actual delivery.

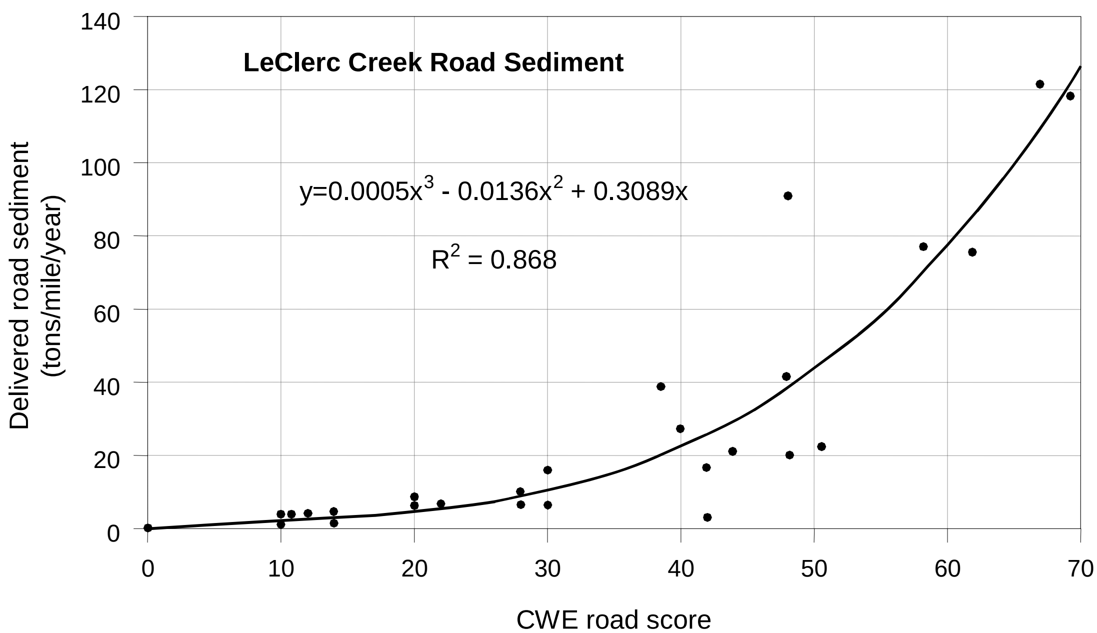

Figure F-1. Sediment export from roads based on CWE scores.

Figure F-1 Sediment Export of Roads Based on Cumulative Watershed Effects Scores
Forest road failure was estimated from actual CWE road fill failure and delivery data. These failures were interpreted as the primary result of large discharge events, which occur on a 10 – 15 year return period (McClelland et al. 1997). The estimates were annualized, by dividing the measured values by 10. Data are typically from a subset of the roads in a watershed. The sediment delivery value was scaled using a factor reflecting the watershed road mileage divided by the road mileage assessed. The sediments delivered through this mechanism contained both fine material (including, and smaller than, pebbles) and coarse material (pebbles and larger sizes). The percentages of fine and coarse particles were estimated using the described characteristics of the soil series found in the watershed. The weighted average of the fines and coarse composition of the B and C soil horizons to a depth of 36 inches were developed using the soils GIS coverage STATSGO, which contains the soils composition data provided by soils survey documents. The B and C horizons' composition was used because these are the strata from which forest roads are normally constructed. Based on the developed soil composition percentage and the estimated probable yield, the tons of fine and coarse material delivered to the streams by fill failure was calculated. This approach assumes equal delivery of fine and coarse materials.

Roads cause stream sedimentation by an additional mechanism. The presence of roads in the floodplain of a stream most often interferes with the stream's natural tendency to seek a steady state gradient. During high discharge periods, the constrained stream often erodes at the roadbed, or, if the bed is armored, erodes at the opposite bank or its bed. The erosion resulting from a road- imposed gradient change results in stream sedimentation. The model assumes the roads causing gradient effects to be those within 200 feet of the stream. The model then assumes 0.25-inch erosion per lineal foot of bed and bank up to three feet in height. The 0.25- inch cross-section erosion is assumed to be uniform over the bed and banks. The erosion rate was selected from a model curve of erosion in inches compared to modeled sediment yields from a channel 10 feet in width. The stream cross-section used was based on the weighted bank full width for all measurements made of streams in the Beneficial Use Reconnaissance and Use Attainability programs. The erosion is determined from the soil types in the basin with the weighted percentages of fine and coarse material. A bulk soil density of 2.6 grams per cubic centimeter is used to convert soil volume into weight in tons. The tons of fine and coarse material are totaled for all road segments within 50 lineal feet of the stream. The bulk of this erosion is assumed to occur during large discharge events which occur on a 10 - 15-year return period (McClelland et. al 1997). The estimates, therefore, are annualized by dividing the measured values by 10.

Estimates of bank recession are appropriate primarily along low gradient Rosgen B and C channels (Rosgen 1985). The direct volume method, as discussed in the Erosion and Sediment Yield Channel Evaluation Workshop (1983), was employed to make the estimates. The method relies on measurements of eroding bank length, lateral recession rate, soil type, and particle size to make these estimates. A field crew collected these data. The fine and coarse material fractions of the bank material based on STATSGO GIS coverage are used to estimate fine and coarse material delivery to the stream. These values are added into the watershed sediment load.

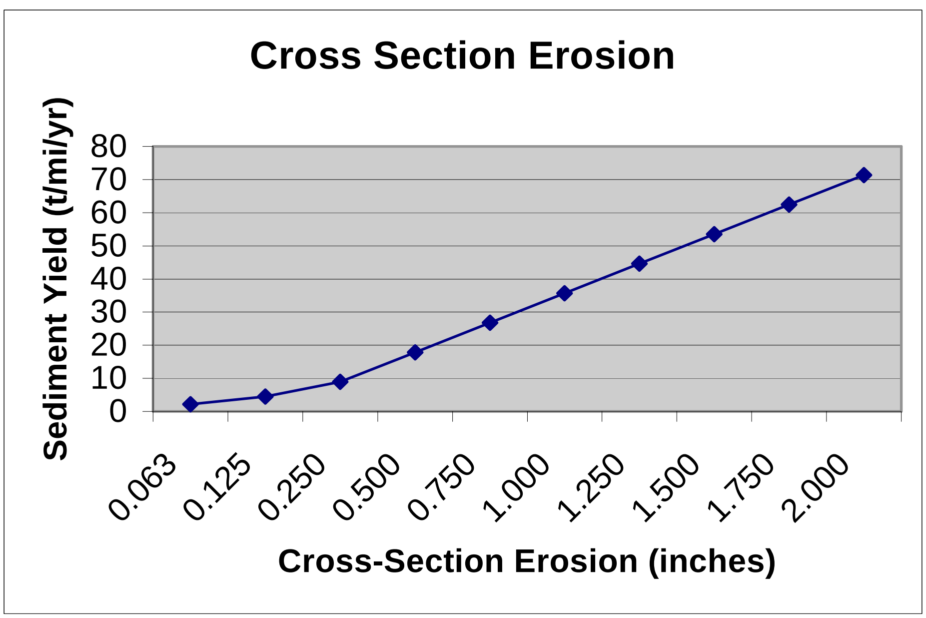

Figure F-2. Modeled Sediment Yield from Thickness of Cross-Section Erosion

The model does not consider sediment routing, nor does it attempt to estimate the erosion to streambeds and banks resulting from localized sediment deposition in the streambed. The model does not attempt to measure the effects of additional water capture at road crossings. It is assumed, that on the balance, the additional stream power created by additional water capture over a shorter period would increase net export of sediment, even though some erosion would be caused by this watershed effect.

Assessment of Model's Conservative Estimate:

Several conservative assumptions were made in the model construction, which cause it to develop conservatively high estimations of sedimentation in the streams modeled. These assumptions are listed in the following paragraphs and a numerical assessment of the magnitude of the conservatism is assigned.

The model uses RUSLE 2 and forest sediment yield coefficients to develop land use sediment delivery estimates. The output values are treated as delivery to the stream. The RUSLE 2 assumes delivery if the slope assessed is immediately up gradient from the stream system. This is not the case on the majority of the agricultural land assessed. Estimates made in the Lake Creek Sediment Study indicate that, at most, 25% of the erosion modeled was delivered as sediment to the stream (Bauer, Golden, and Pettit 1998). A similar local estimate has not been made with sediment yield coefficients, but it is likely that this estimate would be 25% as well. The land use model component is 75% conservative.

The roads crossing component of the model assumes 100% delivery of fine sediment from the 200 feet on either side of a stream crossing and road encroachment of 200 feet upon the stream channel. It is more likely that some fine sediment remains in ditches. A reasonable level of delivery is 80%. The model is likely 20% conservative in this component. On Belt terrain, use of the McGreer model is conservative. Since the sediment yield coefficients measured in-stream for Kaniksu granites are 167% of the coefficient for Belt terrain, this factor is estimated to be 67% conservative.

Fill failure data is developed from actual CWE field assessments. The CWE assessment does not assess all the roads in the watershed. The percentage of watershed roads assessed varies, but it is commonly 60% or less of the watershed roads. The model is 40% conservative in this component. Table F-1 summarizes the conservative assumptions and assesses its numerical level of overestimation.

Table F-1. Conservative estimate of stream sedimentation provided by the sediment model.

Model Factor	Kaniksu Granites (% conservative)	Belt Supergroup (% conservative)
100% RUSLE 2 and forest land sediment yield delivery	75%	75%
Crossing delivery	29%	20%
McGreer model	0%	67%
Road encroachment at 50 feet	20%	20%
Road failure	40%	40%
Total assessment of overestimate	**164%**	**231%**

The model provides an overestimate by factors of 1.6 and 2.3 for the Kaniksu and Belt terrain, respectively. This overestimation is a built-in margin of safety of 231%.

Model Verification:

Attempts to verify similar modeling approaches used in the Kootenai and Moyie Rivers sediment TMDL have been conducted within the northern Idaho region. Verification of the model can be developed by comparing measured sediment loads with those predicted by the model. For example, the United States Geological Survey measured sediment load at the Enaville Station on the Coeur d'Alene River during water year 1999. Based on these measured estimates, the sediment load per square mile of the basin above this point was calculated to be 28 tons (URS Greiner 2001). The middle value of the Belt geology sediment yield coefficient range is 14.7 tons per square mile. The model predicted a sediment yield of 33.6 tons/year for the entire subbasin. The agreement between the measured estimates and the modeled estimates is good.

Appendix F. References Cited

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